Single Aisle
TECHNICAL TRAINING MANUAL
CMQ Intra Family - A319/320/321 IAE V2500 to A318/319/320/321 CFM 56 - T1/T1+T2
POWER PLANT CFM 56

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POWER PLANT CFM 56

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UG913131 - U7RT0EC

70 POWER PLANT CFM 56 PRESENTATION (1)

INTRODUCTION

The CFM56-5B engine is a dual-rotor, variable stator, high bypass ratio turbo fan power plant. The CFM56-5B powers the complete single aisle family of aircraft. CFM56-5B engines are available in several thrust ratings.
All the engines are basically the same. A programming plug on the Electronic Control Unit (ECU) changes the available thrust.

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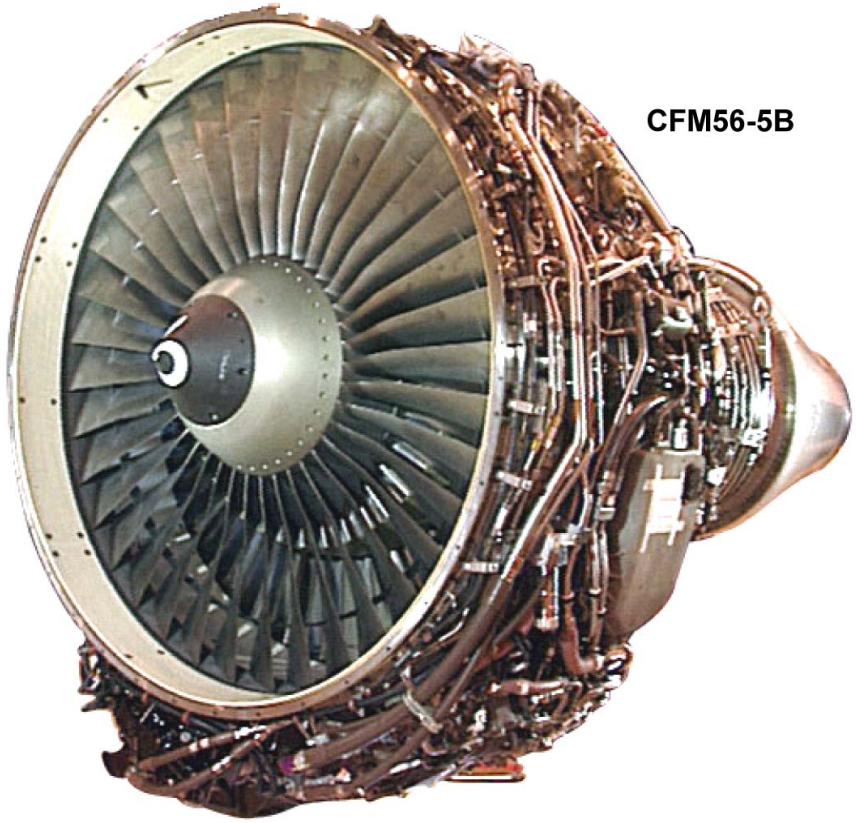
A/C	ENGINE	THRUST (lbs)	THRUST (kg)
A318	CFM56-5B8 CFM56-5B9	21,600 lbs 23,300 lbs	9,800 kg 10,570 kg
A319	CFM56-5B5 CFM56-5B6	22,000 lbs 23,500 lbs	9,980 kg 10,660 kg
A319 CJ	CFM56-5B7	27,000 lbs	12,250 kg
A320	CFM56-5B4	27,000 lbs	12,250 kg
A321	CFM56-5B1 CFM56-5B2 CFM56-5B3	30,000 lbs 31,000 lbs 33,000 lbs	13,610 kg 14,060 kg 14,970 kg



INTRODUCTION

70 POWER PLANT CFM 56 PRESENTATION (1)

INSTALLATION

The power plant installation includes the engine, the engine inlet, the exhaust, the fan cowls and the reverser assemblies. The pylon connects the engine to the wing structure. The engine is attached to the pylon by forward and aft mounts.

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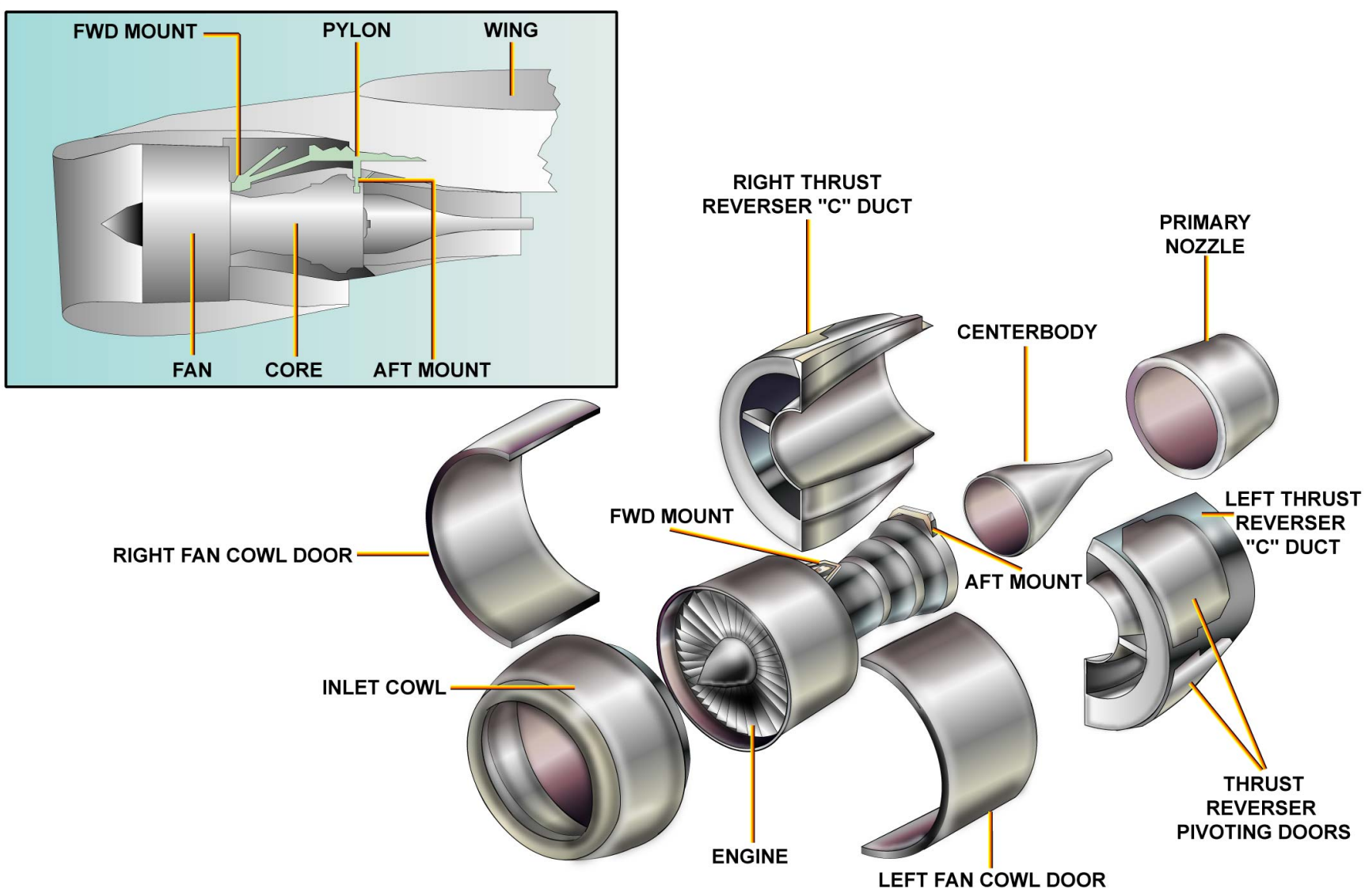

INSTALLATION

70 POWER PLANT CFM 56 PRESENTATION (1)

MODULAR CONCEPT

The CFM56-5B is designed using a modular concept. For easy maintenance and quicker return-to-service, the engine is made of 4 primary modules:
- Fan and Low Pressure (LP) compressor,
- High Pressure (HP) compressor, combustion chamber and HP turbine,
- LP turbine and Turbine Rear Frame (TRF),
- Transfer and accessory gearboxes.

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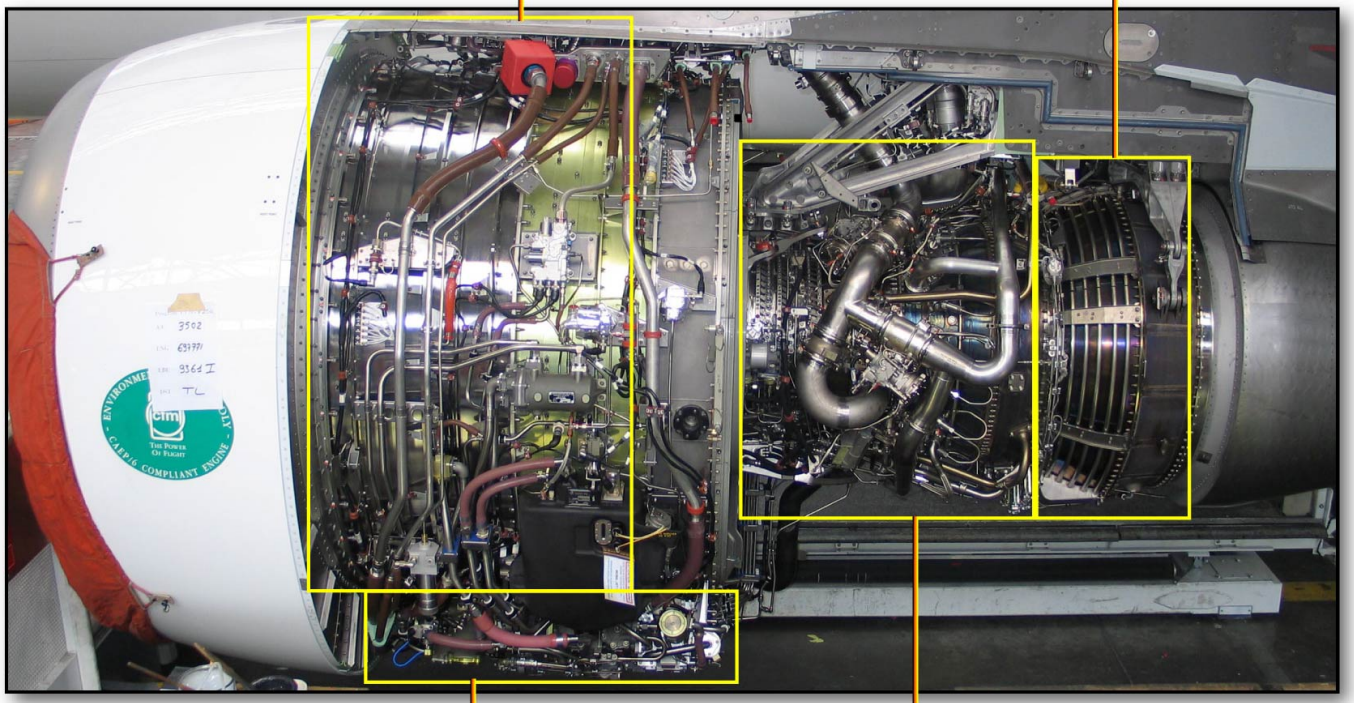

MODULAR CONCEPT

70 POWER PLANT CFM 56 PRESENTATION (1)

MODULAR CONCEPT (continued)

LP ROTOR

The Low Pressure (LP) rotor has the forward fan, the booster compressor and the LP shaft, all driven by the LP turbine. The speed of the LP rotor is indicated on the ECAM as N1.
The forward fan supplies most of the engine thrust. The air produced by the fan is known as secondary airflow or bypass airflow. The 4-stage booster compressor supplies air to the engine core. This is primary airflow. The fan and LP compressor are supported by the fan frame which is also the location for the forward engine mount.
The 4-stage LP turbine drives the forward fan and the booster compressor. It is supported by the TRF to which the rear engine mount is attached.
The LP rotor is supported by roller and ball bearings which are lubricated and cooled.

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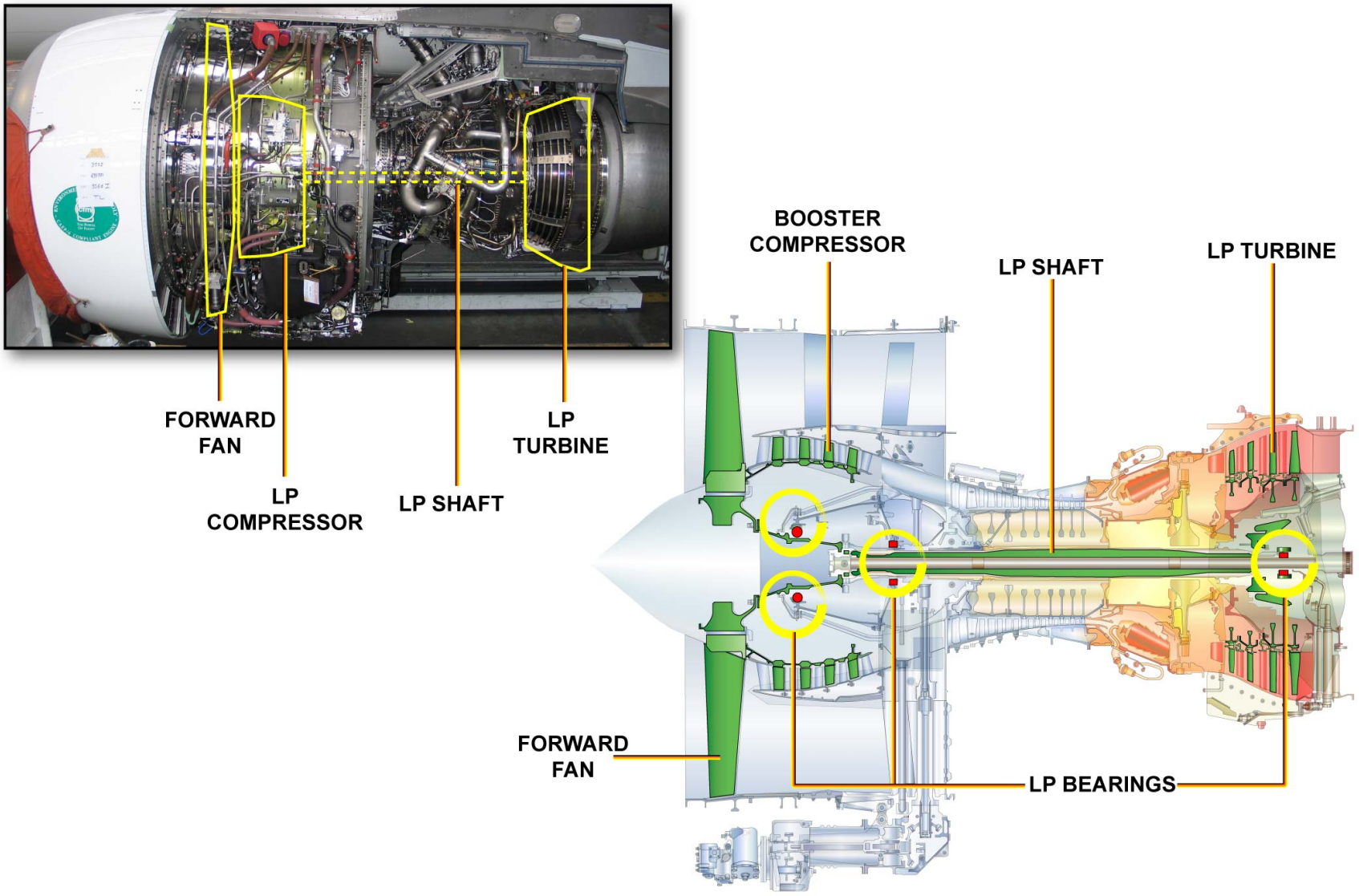

MODULAR CONCEPT - LP ROTOR

70 POWER PLANT CFM 56 PRESENTATION (1)

MODULAR CONCEPT (continued)

HP ROTOR AND COMBUSTION CHAMBER

The High Pressure (HP) rotor is made up of a 9-stage HP compressor driven by a single-stage HP turbine. The speed of the HP rotor is indicated on the ECAM as N2.
The HP compressor is also the source of customer bleed air.
The HP rotor is supported by roller and ball bearings, which are lubricated and cooled.
The annular combustion chamber is installed between the HP compressor and HP turbine. It has ports for 20 fuel nozzles and 2 igniter plugs.

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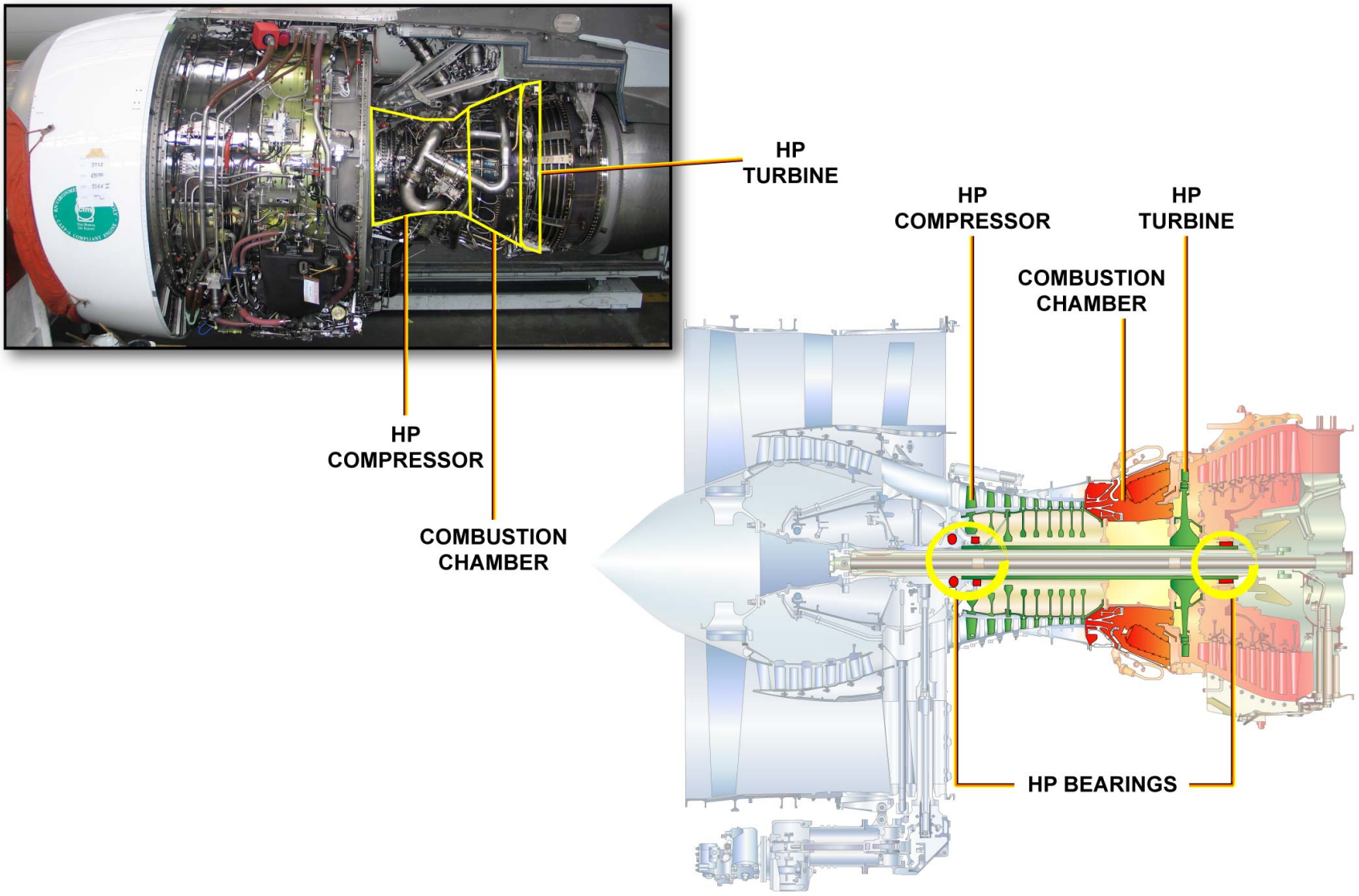

MODULAR CONCEPT - HP ROTOR AND COMBUSTION CHAMBER

70 POWER PLANT CFM 56 PRESENTATION (1)

MODULAR CONCEPT (continued)

TRANSFER & ACCESSORY GEARBOXES

The accessory gearbox is installed at the bottom of the fan case and is driven by the HP rotor through the transfer gearbox.
The fuel pumps, oil pumps, hydraulic pump, Integrated Drive Generator (IDG) and FADEC alternator are all driven by the gearbox.
During engine starting, the starter rotates the HP compressor through the gearboxes.

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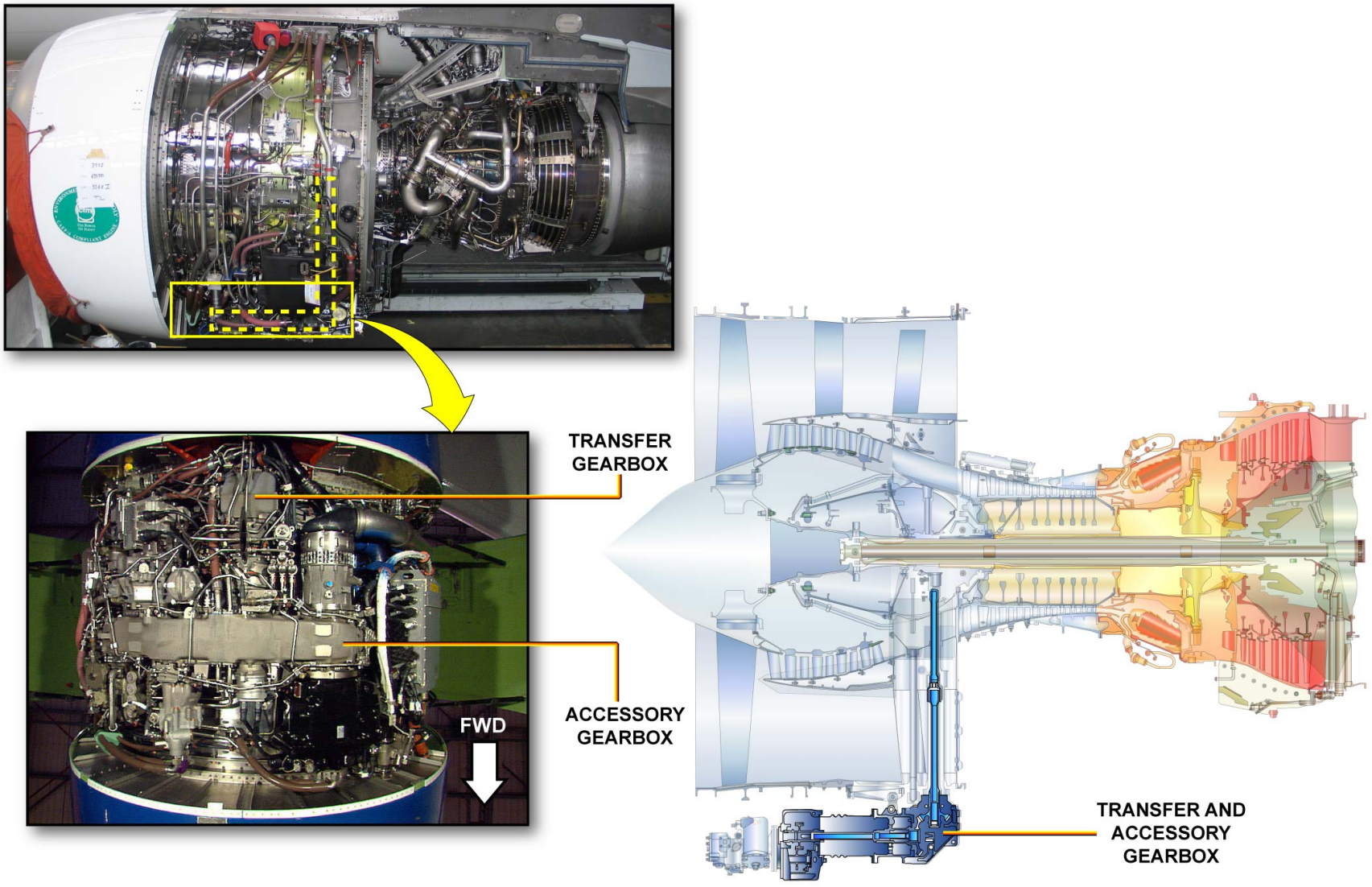

MODULAR CONCEPT - TRANSFER & ACCESSORY GEARBOXES

70 POWER PLANT CFM 56 PRESENTATION (1)

FADEC

In order to increase engine reliability and efficiency, the Full Authority Digital Engine Control (FADEC) gives the full range of engine control to achieve steady state and transient engine performances when operated in combination with aircraft subsystems.
Each engine is controlled by an ECU. The ECU is a dual channel computer. The ECU controls the engine during start and all operations. The ECU manages engine thrust and protects against overspeed and overtemperature by controlling the engine sub-systems. The ECU also monitors all engine subsystems and sensors for failure. When the engine is running, power for FADEC operation is supplied by a dual-output FADEC alternator driven by the gearbox.
The FADEC system has a dual channel ECU and the following peripherals:
- Hydromechanical unit,
- Dedicated FADEC alternator,
- Compressor control systems,
- Clearance control systems,
- Start system (starter shutoff valve, ignition exciters),
- Thrust reverser system,
- Oil/fuel temperature control system,
- Fuel return valve,
- Engine sensors,
- Electrical harnesses.

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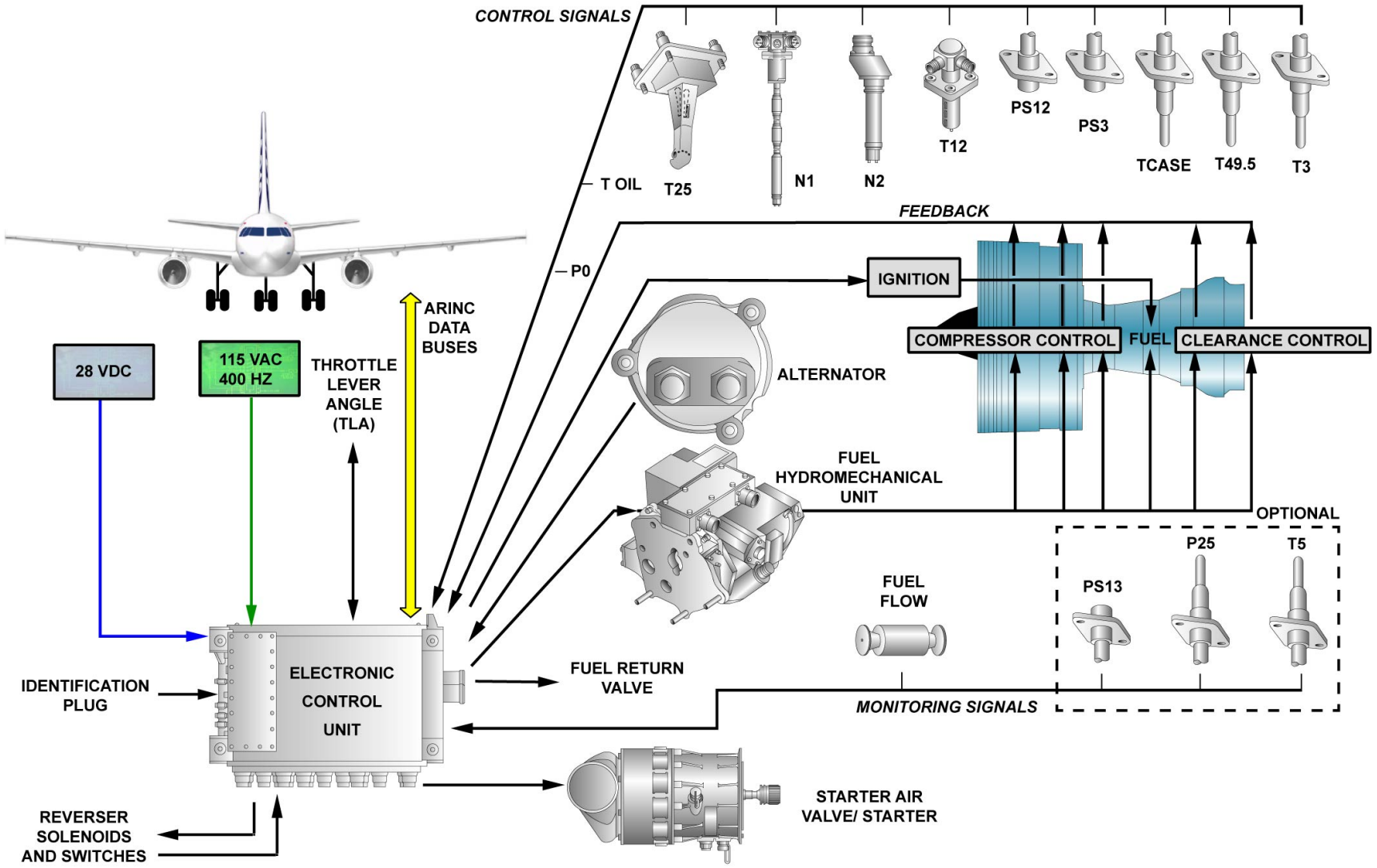

FADEC

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70 POWER PLANT CFM 56 PRESENTATION (1)

EIU/EVMU

The ECU interfaces with various aircraft systems. Essential communication with the ECU (thrust lever position, air data, etc.) is direct from the applicable systems and controls. Non-essential communication (autothrust, Centralized Fault Display System (CFDS), etc) is routed through the Engine Interface Unit (EIU) of each engine. The EIUs interface with various aircraft circuits and systems. The data is then transmitted in a single stream to each ECU channel.
Engine vibration monitoring is accomplished by the Engine Vibration Monitoring Unit (EVMU). The EVMU collects vibration data from both engines. The vibration information is displayed on the ECAM and is also available through the CFDS for troubleshooting.

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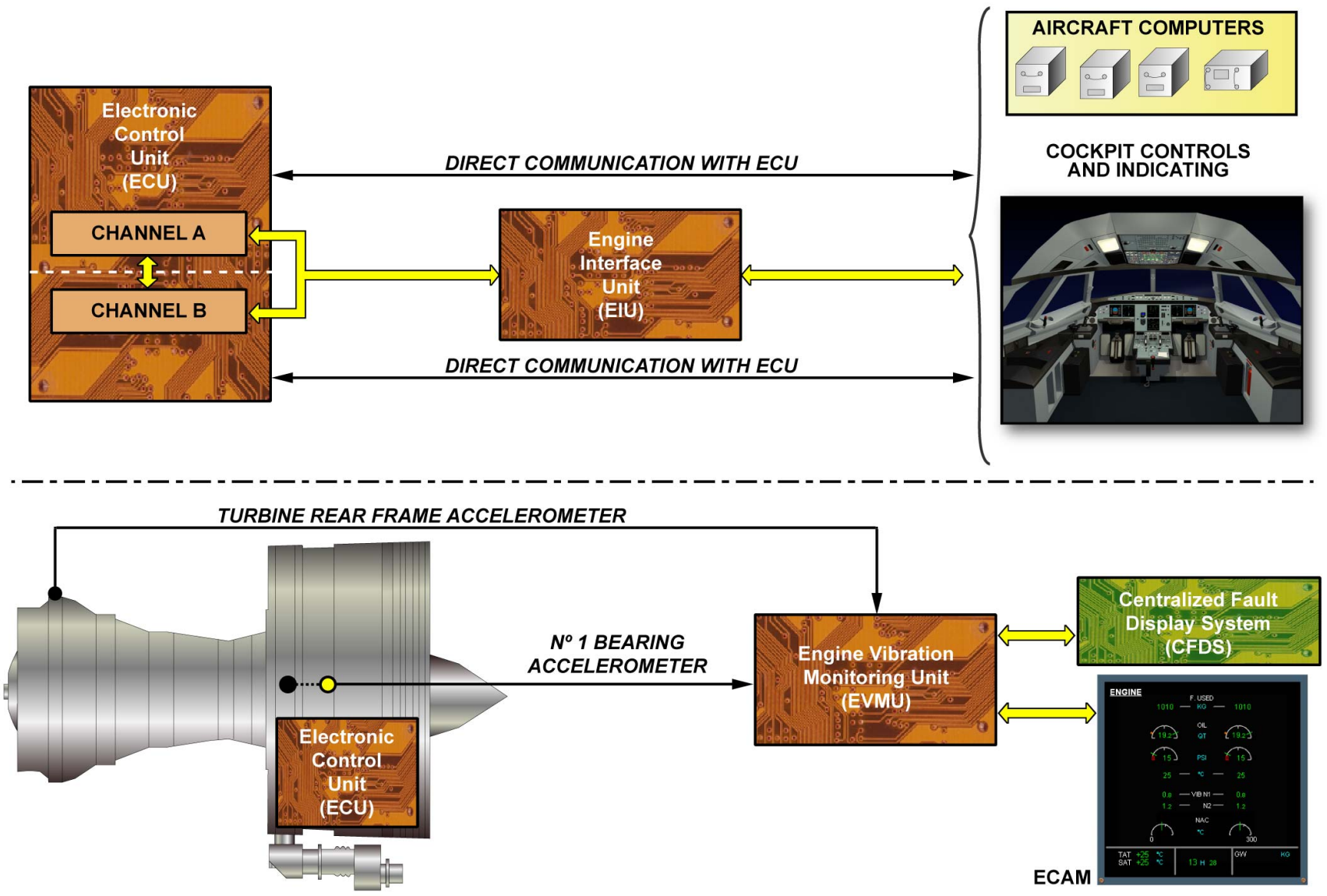
AIRCRAFT COMPUTERS
Electronic Control Unit (ECU)
CHANNEL A
CHANNEL B
DIRECT COMMUNICATION WITH ECU
Engine Interface Unit (EIU)
DIRECT COMMUNICATION WITH ECU
COCKPIT CONTROLS AND INDICATING
TURBINE REAR FRAME ACCELEROMETER
Nº 1 BEARING ACCELEROMETER
Electronic Control Unit (ECU)
Engine Vibration Monitoring Unit (EVMU)
Centralized Fault Display System (CFDS)
ECAM

EIU/EVMU

70 POWER PLANT CFM 56 PRESENTATION (1)

THRUST REVERSER SYSTEM

The flight crew manually selects reverse thrust by lifting the latching levers on the throttle control levers. The Spoiler Elevator Computer (SEC) opens the hydraulic shut-off valve to enable operation of the thrust reverser. The reverse thrust command is sent to the ECU and the Engine Interface Unit (EIU). The deploy command from the ECU to the Hydraulic Control Unit (HCU) is fed to an inhibition relay controlled by the EIU according to the throttle control lever position.
According to commands from the ECU and the EIU, a Hydraulic Control Unit (HCU) supplies hydraulic power to operate the thrust reverser. The thrust reverser uses 4 hydraulically actuated pivoting blocker doors to redirect the engine fan airflow.
Reverse thrust is only available on the ground.

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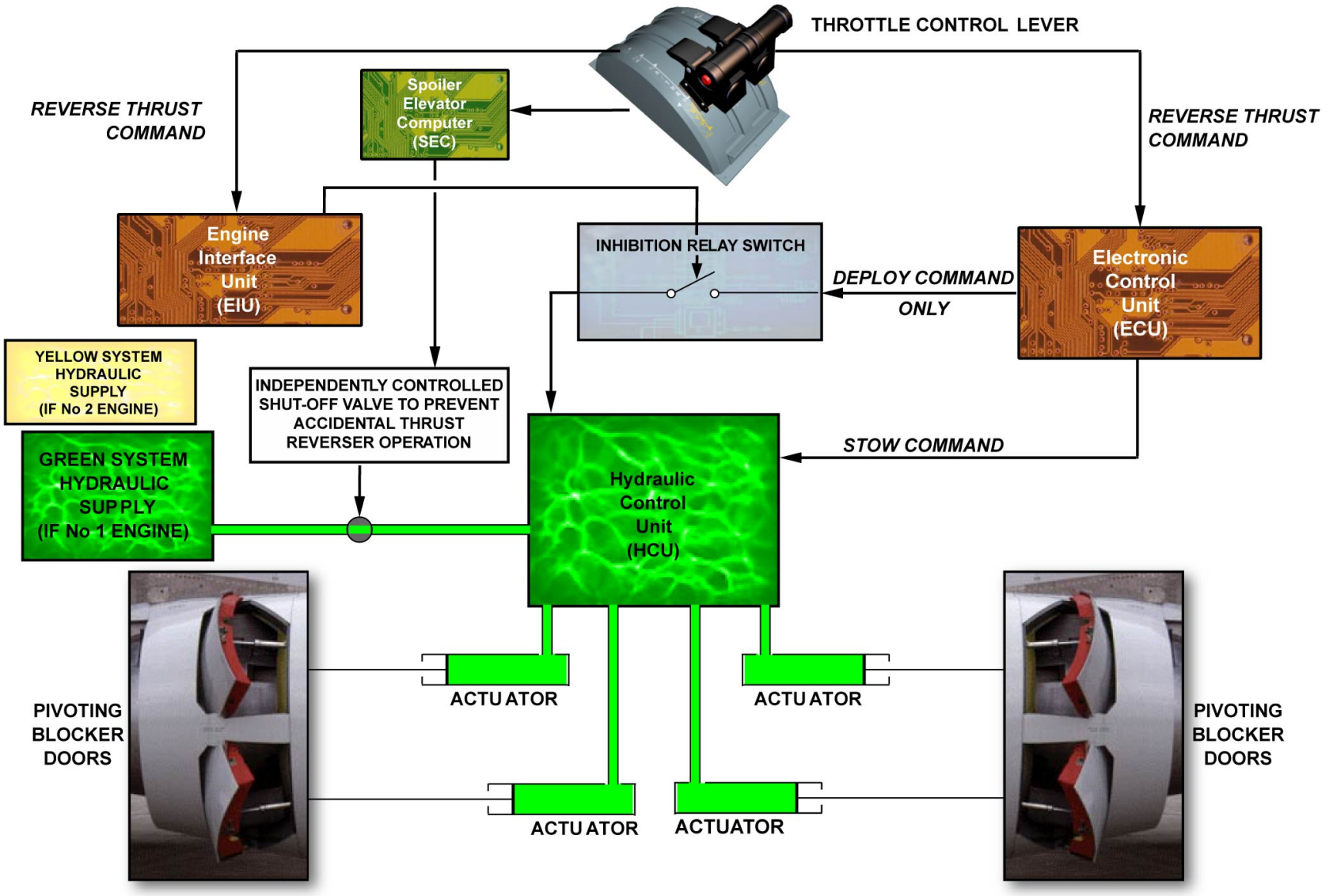

THRUST REVERSER SYSTEM

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THRUST REVERSERS STOWED
- PIVOTING BLOCKER DOORS CLOSED -

THRUST REVERSERS DEPLOYED
- PIVOTING BLOCKER DOORS OPEN -

THRUST REVERSER SYSTEM

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70 POWER PLANT CFM 56 PRESENTATION (1)

CONTROL AND INDICATING

This section will highlight the control panels and indications for the engines.

CONTROL PANELS

The engines are controlled by throttle control levers which are installed on the center pedestal. They can only be moved manually.
For reverse thrust operation, two latching levers let the throttle control levers move rearward into the reverse thrust section.
The A320 family aircraft normally operate in the auto thrust mode, when in flight.
The autothrust can be disconnected with the two instinctive disconnect pushbuttons (2 red buttons are installed on the outside of the lever). This lets the engines be controlled in manual thrust mode.
The controls for engine starting and shutdown are installed on the center pedestal immediately behind the throttle control levers.
The engine MAN START switches are installed on the overhead panel. These switches are used to start an engine during a manual start procedure. They are also used during a dry or wet motoring procedure.

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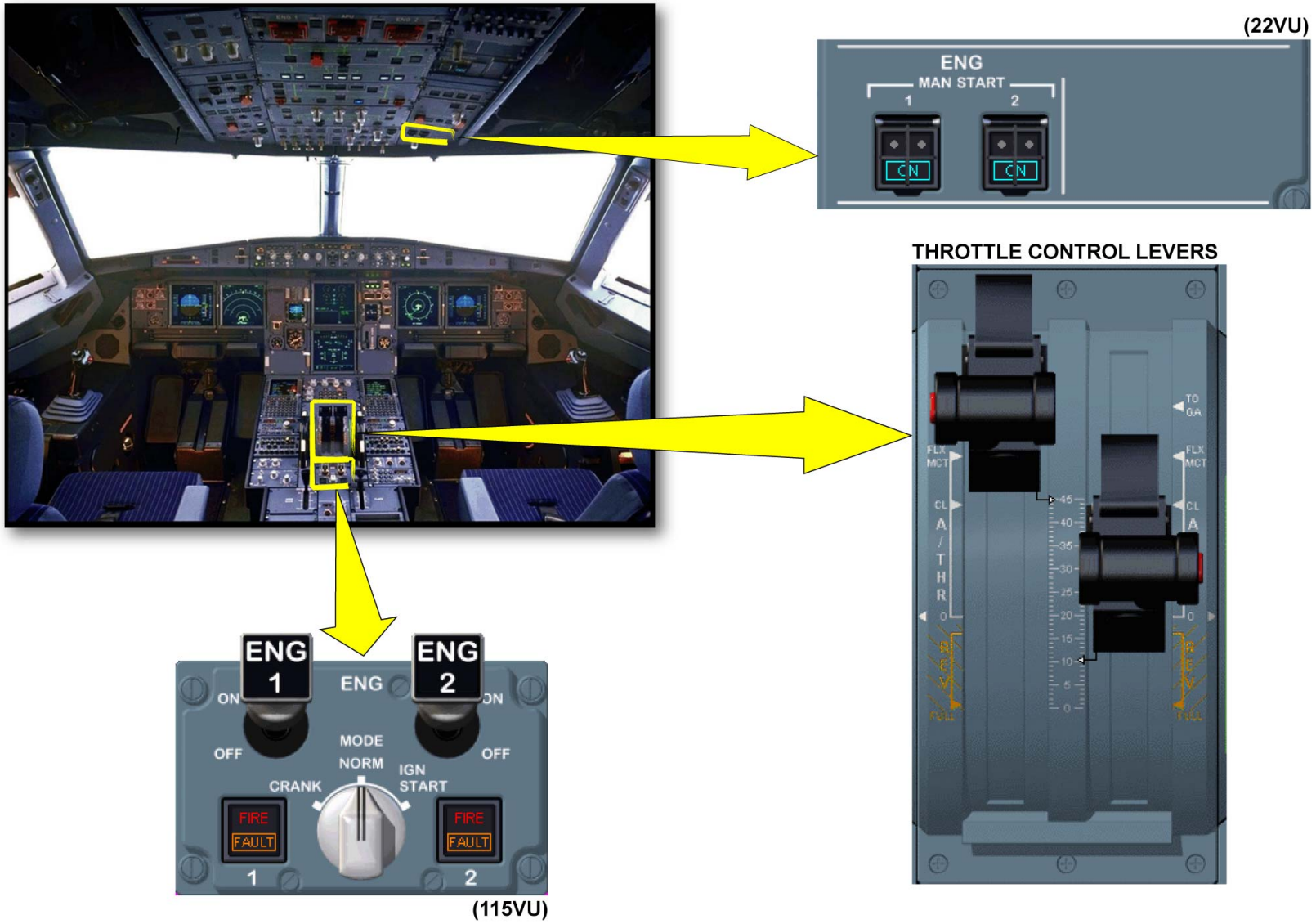

CONTROL AND INDICATING - CONTROL PANELS

70 POWER PLANT CFM 56 PRESENTATION (1)

CONTROL AND INDICATING (continued)

ECAM ENGINE

The engine primary parameters are permanently displayed on the upper ECAM.
The engine secondary parameters are presented on the lower ECAM ENGINE page when selected or displayed automatically during engine start or a fault.
Some engine parameters are permanently displayed on the CRUISE page in flight.

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CONTROL AND INDICATING - ECAM ENGINE

70 POWER PLANT CFM 56 PRESENTATION (1)

MAINTENANCE/TEST FACILITIES

On the maintenance panel, the ENG FADEC GND PWR is used to supply the FADEC system for maintenance tasks, when the engines are not running.
The MCDU is used to do tests and for trouble shooting monitored components (computers, sensors, actuators).

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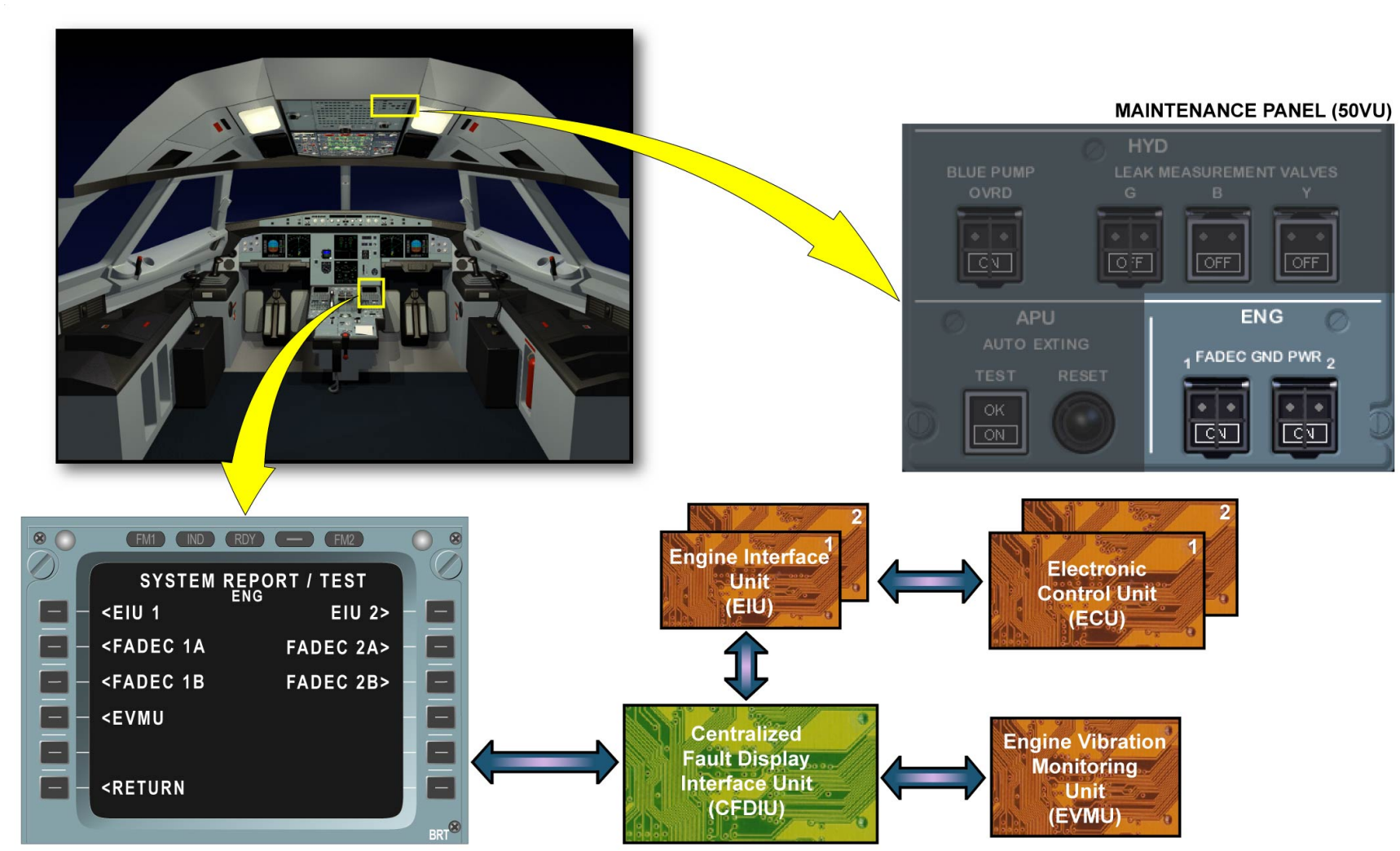

MAINTENANCE/TEST FACILITIES

70 POWER PLANT CFM 56 PRESENTATION (1)

SAFETY PRECAUTIONS

When you work on aircraft, make sure that you obey all the Aircraft Maintenance Manual (AMM) safety procedures.
This will prevent injury to persons and/or damage to the aircraft. Here is an overview of main safety precautions related to the engines.
Make sure that all engine danger areas are as clear as possible to prevent damage to the engine, the aircraft or persons in the area.
Be careful: The entry corridor will be closed when the engine power is above the minimum.
Make sure that you have fire-fighting equipment available.
Do not try to stop the fan from turning by hand.
After engine shutdown, let the oil tank pressure bleed off for a minimum of 5 minutes before you remove the tank filler cap. If you do not, pressurized oil can flow out of the tank and cause dangerous burns.
The engine ignition system is an electrical system with high energy. You must be careful to prevent electrical shock. Injury or death can occur. Do not do maintenance on the ignition system while the engine operates.
Make sure that the engine shutdown occurred more than 5 minutes ago before you continue with the maintenance procedure.
Make sure that the thrust reverser is deactivated during maintenance. If not, the thrust reverser can operate accidentally and cause injury to personnel and/or damage to the reverser.
When opening the engine cowls:
o Respect the wind limitations and the opening/closing sequence,
o Always secure cowls with the hold-open rods,
o Make sure that the slats are retracted and install a warning notice to prevent slat operation.

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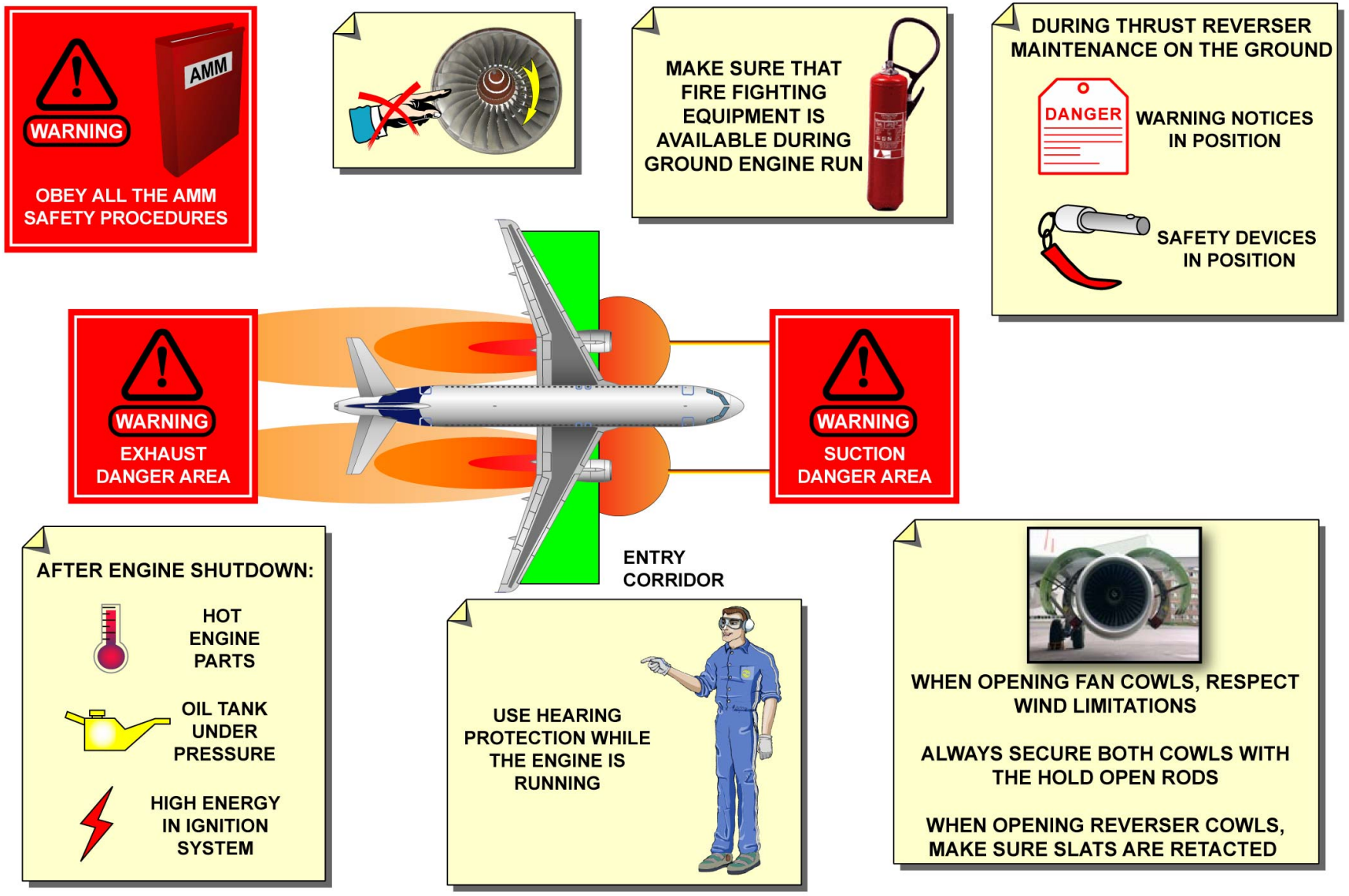
WARNING
AMM
OBEY ALL THE AMM SAFETY PROCEDURES
MAKE SURE THAT FIRE FIGHTING EQUIPMENT IS AVAILABLE DURING GROUND ENGINE RUN
DURING THRUST REVERSER MAINTENANCE ON THE GROUND
DANGER
WARNING NOTICES IN POSITION
SAFETY DEVICES IN POSITION
WARNING
EXHAUST DANGER AREA
WARNING
SUCTION DANGER AREA
ENTRY CORRIDOR
AFTER ENGINE SHUTDOWN:
HOT ENGINE PARTS
OIL TANK UNDER PRESSURE
HIGH ENERGY IN IGNITION SYSTEM
USE HEARING PROTECTION WHILE THE ENGINE IS RUNNING
WHEN OPENING FAN COWLS, RESPECT WIND LIMITATIONS
ALWAYS SECURE BOTH COWLS WITH THE HOLD OPEN RODS
WHEN OPENING REVERSER COWLS, MAKE SURE SLATS ARE RETACTED

SAFETY PRECAUTIONS

70 POWER PLANT CFM 56 PRESENTATION (1)

LUBRICANTS AND FUELS

The list of the materials required for the aircraft service and maintenance can be found in the AMM, Chapter 20 STANDARD PRACTICES or Chapter 70 STANDARD PRACTICES for the engines.

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AMM ATA 20 STANDARD PRACTICES
20-31-00 LIST OF MATERIALS

ITEM	DESIGNATION	SPECIFICATIONS
.	.	.
.	.	.
.	.	.
01-001	FUEL, TURBO	REF JET A-1
.	.	.
.	.	.

AMM ATA 70 STANDARD PRACTICES
70-30-00 (IAE) LIST OF MATERIALS

ITEM Nº	MATERIAL DESIGNATION	SPECIFICATIONS	CODE SUPPLIER
.	.	.	.
V10-077A	APPROVED ENGINE OIL	MOBIL JET II	19135 K1932
V10-077C	APPROVED ENGINE OIL	AEROSHELL 560	K1315 5427
V10-077C	APPROVED ENGINE OIL	BP TURBO OIL 2380	29700 K1274
.	.	.	.
.	.	.	.

LUBRICANTS AND FUELS

70 POWER PLANT CFM 56 PRESENTATION (1)

STORAGE AND PRESERVATION

Storage and preservation procedures must be applied to engines which are not operated. The preservation procedures protect the engine against corrosion, liquid and debris entering the engine, and atmospheric conditions during period of inactivity.

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STORAGE AND PRESERVATION PROCEDURES MUST BE APPLIED FOR ENGINES WHICH ARE NOT OPERATED.

PROTECTION AGAINST ATMOSPHERIC CONDITIONS

THE PRESERVATION PROCEDURES PROTECT THE ENGINE AGAINST CORROSION, LIQUID AND DEBRIS ENTERING THE ENGINE, AND ATMOSPHERIC CONDITIONS DURING PERIOD OF INACTIVITY.

CAUTION

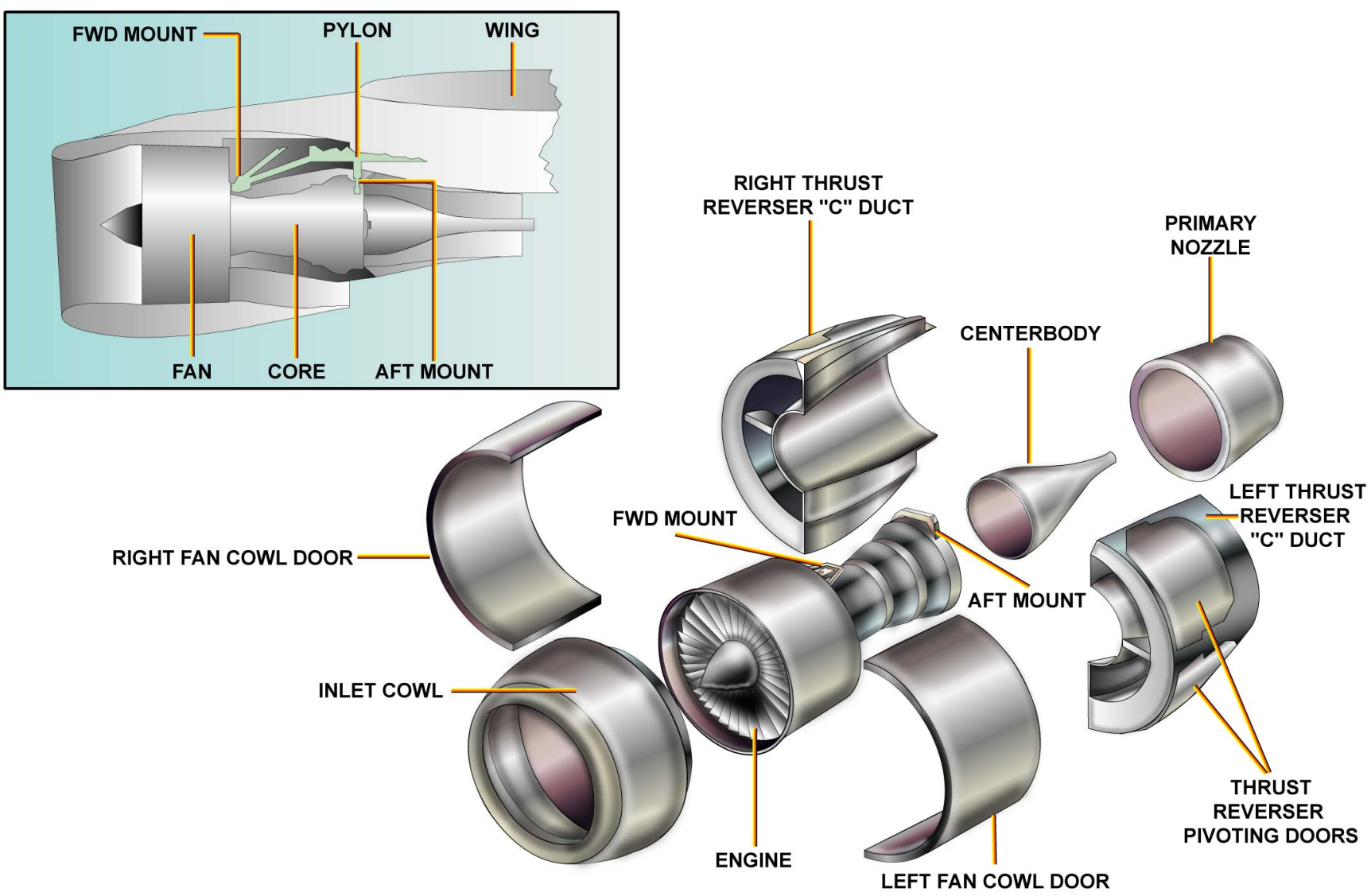
UNDER NO CIRCUMSTANCES SHALL PRESERVATIVE OIL OR EQUIVALENT BE SPRAYED INTO THE ENGINE INLET, CORE COMPRESSOR OR TURBINE, OR ENGINE EXHAUST. DIRT PARTICLES DEPOSITED ON THE WET BLADES AND VANES MAY ADVERSELY AFFECT ENGINE PERFORMANCE DURING SUBSEQUENT OPERATION.

STORAGE AND PRESERVATION

POWERPLANT SYSTEM COMPONENT LOCATION (2)

SYSTEM OVERVIEW

The CFM56-5B engine is a dual-rotor, variable stator, high-bypass-ratio turbo-fan power plant. The CFM56-5B can power all aircraft types of the Single Aisle family. CFM56-5B engines are available in several thrust ratings.
All the engines have the same basic configuration. A programming plug on the Electronic Control Unit (ECU) changes the available thrust.
The power plant installation includes the engine, the engine inlet, the exhaust, the fan cowls and the reverser assemblies. The pylon connects the engine to the wing structure. The engine is attached to the pylon by forward and aft mounts.



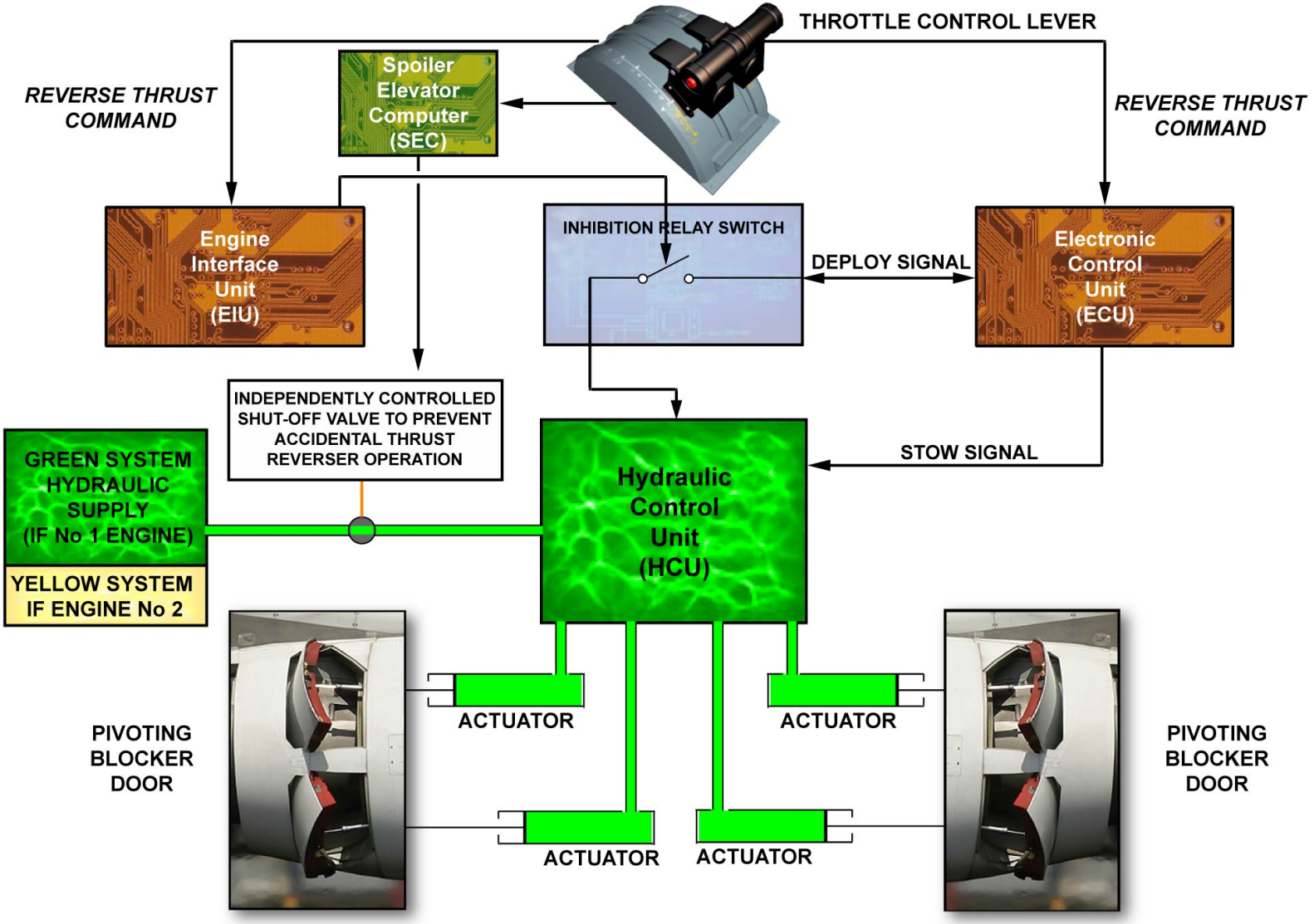
SYSTEM OVERVIEW

POWERPLANT SYSTEM COMPONENT LOCATION (2)

SYSTEM OVERVIEW (continued)

THRUST REVERSER SYSTEM

The reverse thrust is controlled by the ECU. A manual selection of the reverse is done when the flight crew lifts the latching levers on the throttle control levers. The reverse thrust command is sent to the ECU and the Engine Interface Unit (EIU). The signal from the ECU to the directional valve is supplied to an inhibition relay controlled by the Engine Interface Unit (EIU) in relation to the position of the throttle control lever.
In relation to commands from the ECU, a Hydraulic Control Unit (HCU) supplies hydraulic power to operate the thrust reverser. The thrust reverser uses 4 hydraulically operated pivoting blocker doors to redirect the engine fan airflow.



SYSTEM OVERVIEW - THRUST REVERSER SYSTEM

POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION

The engine system components are at the following locations.

FADEC

The ECU is on the RH side of the fan case. The FADEC alternator is on the gearbox.

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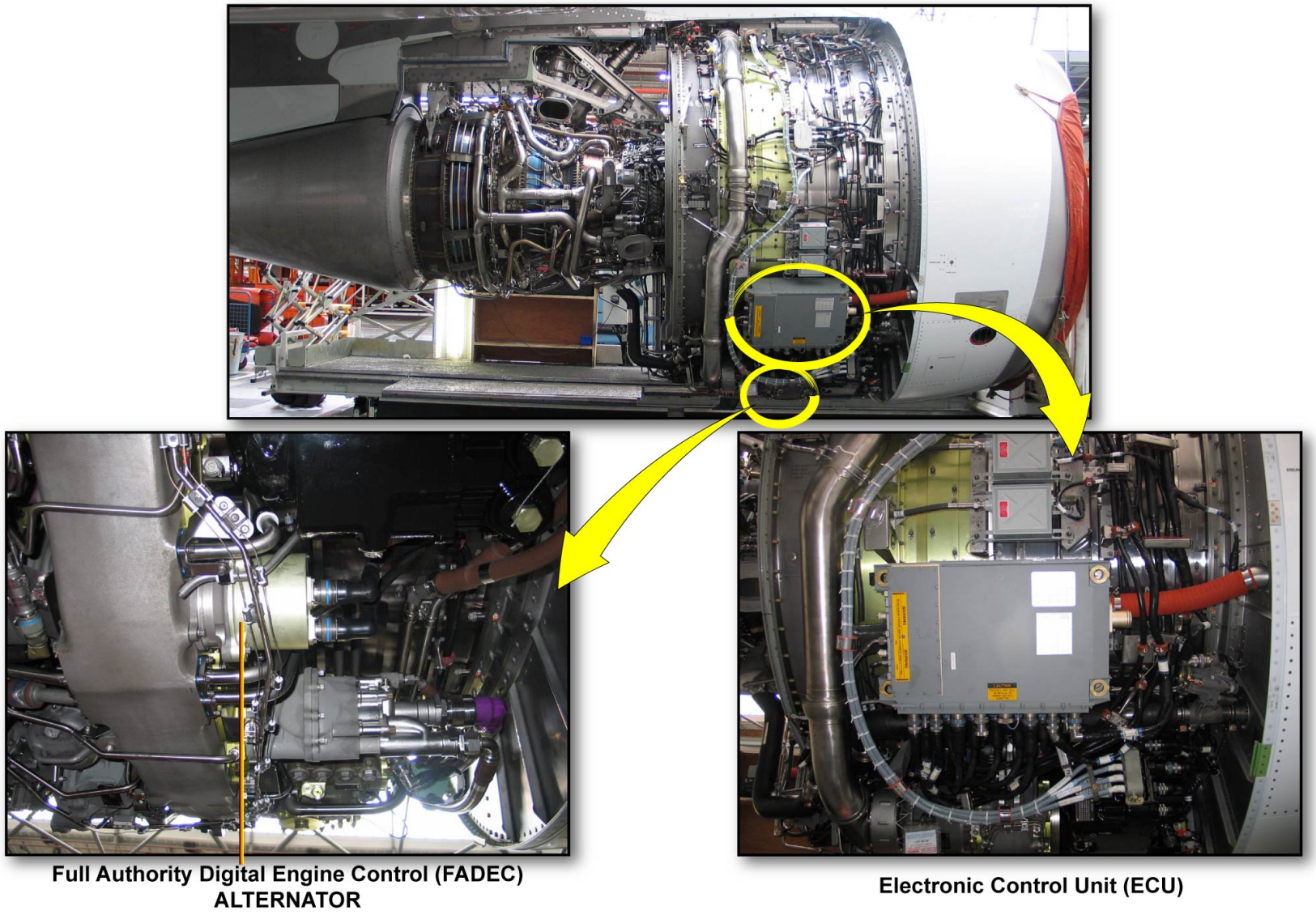

COMPONENT LOCATION - FADEC

POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION (continued)

STARTING

Two ignition boxes are on the RH side of the engine core. The air starter is on the RH side of the gearbox rear face.

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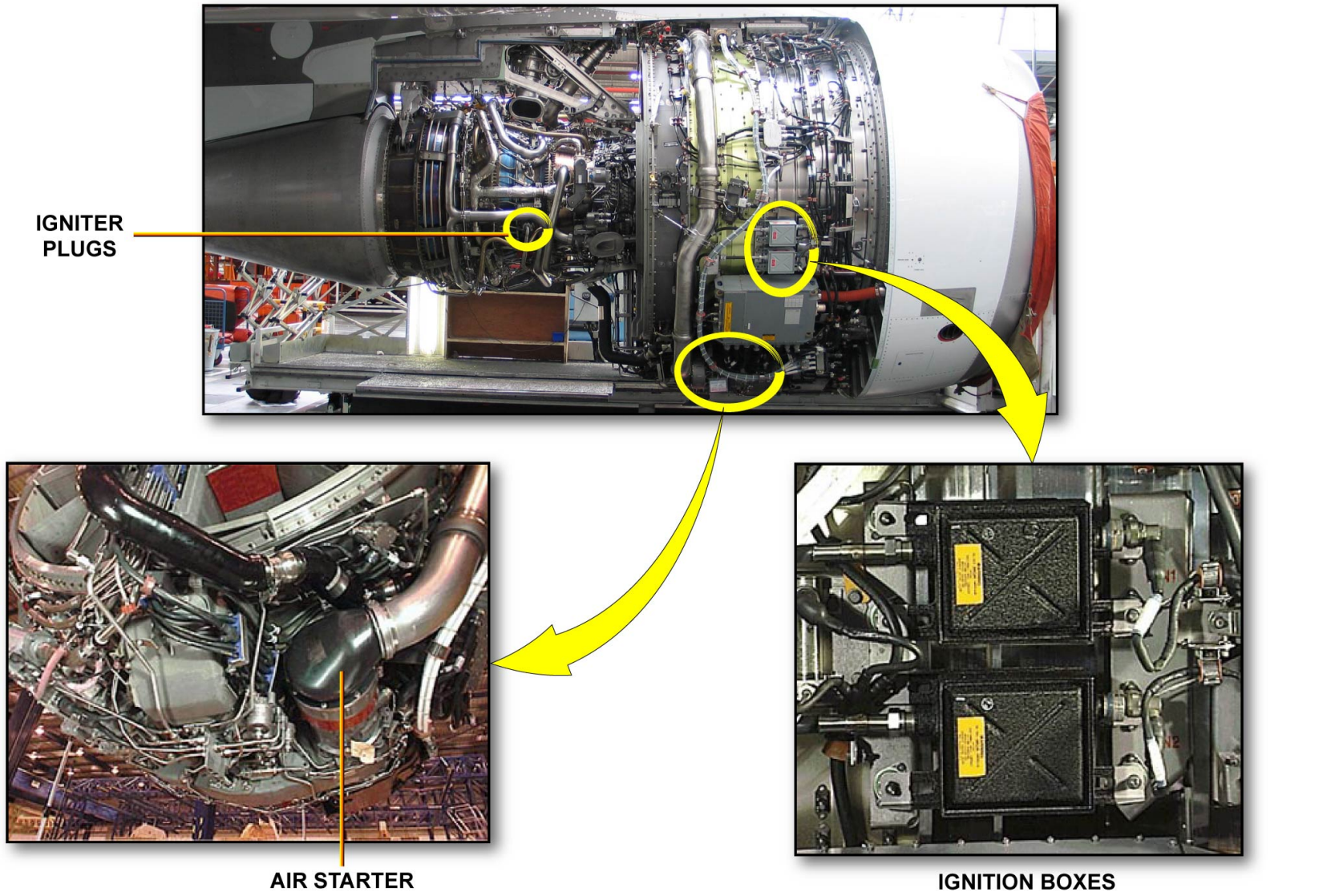


COMPONENT LOCATION - STARTING

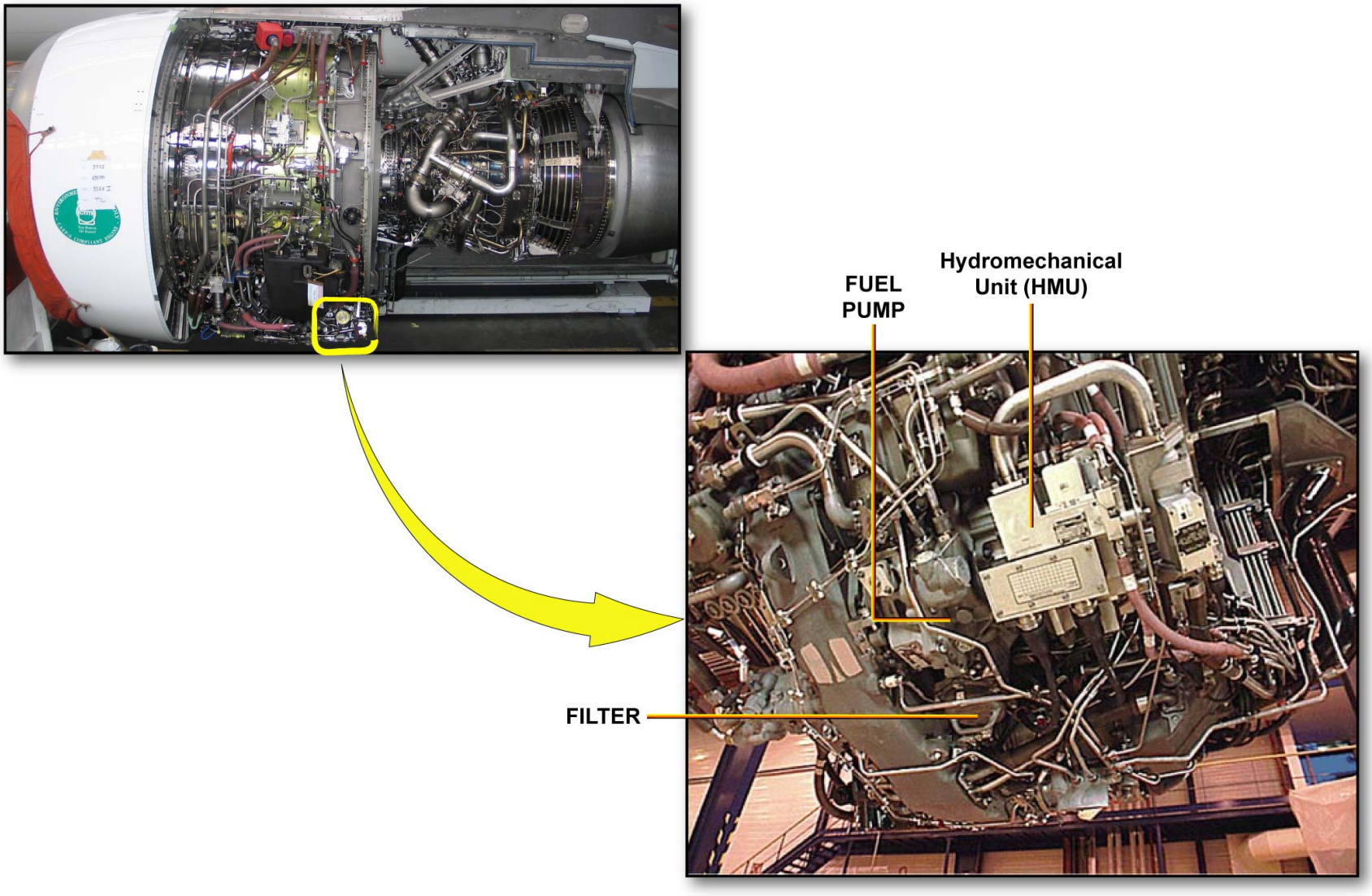
POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION (continued)

FUEL

The primary components of the fuel system are installed on the LH side of the fan compartment.
The fuel pump is operated by the gearbox. The Hydro-Mechanical Unit (HMU) and the filter are installed with the pump.

UG913131 - U7RT0EC - UM70C1COMPLOC01



COMPONENT LOCATION - FUEL

POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION (continued)

AIR

The next picture shows the compressor airflow control system, the turbine clearance control system and the transient bleed valve system.

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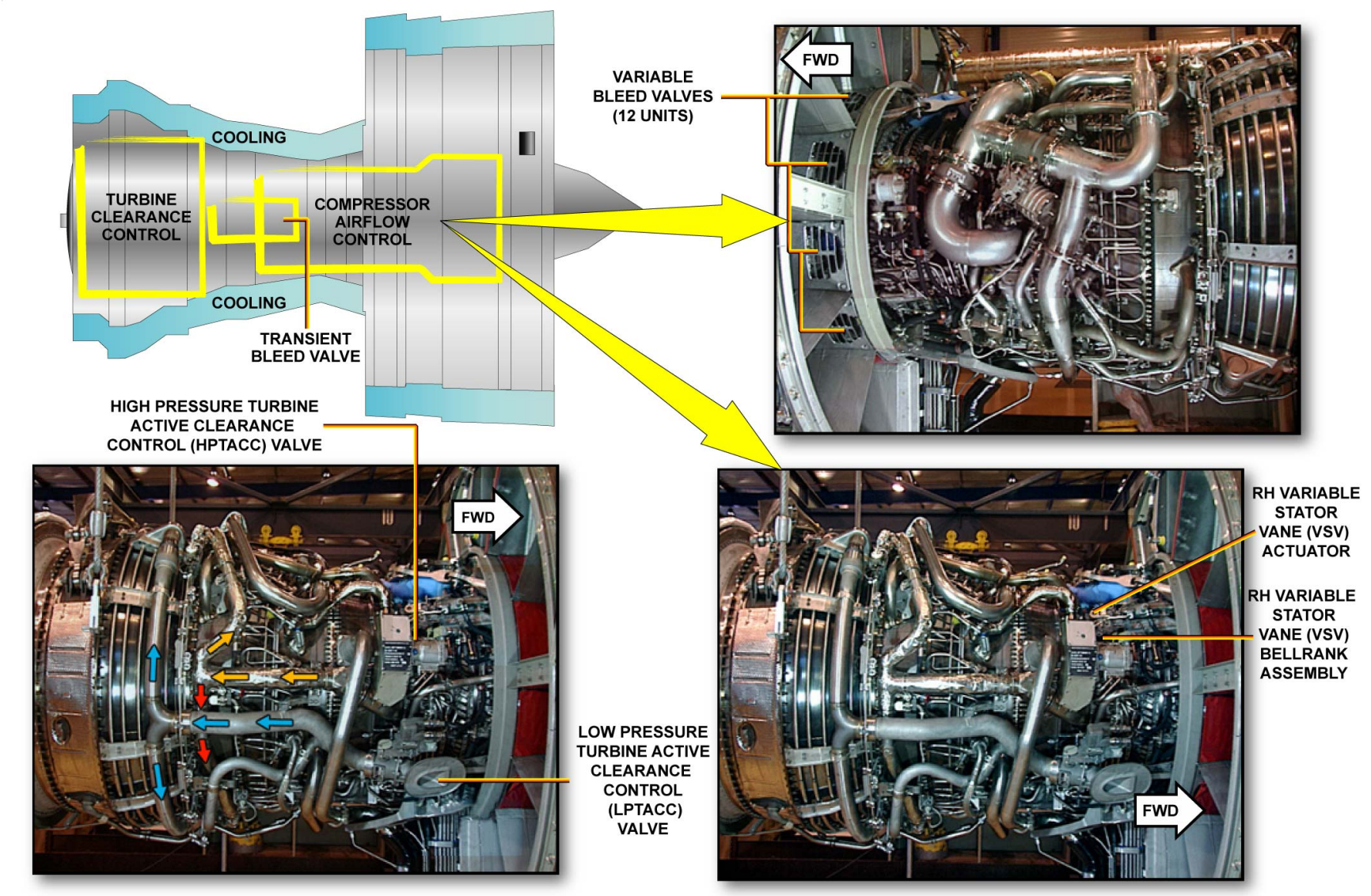


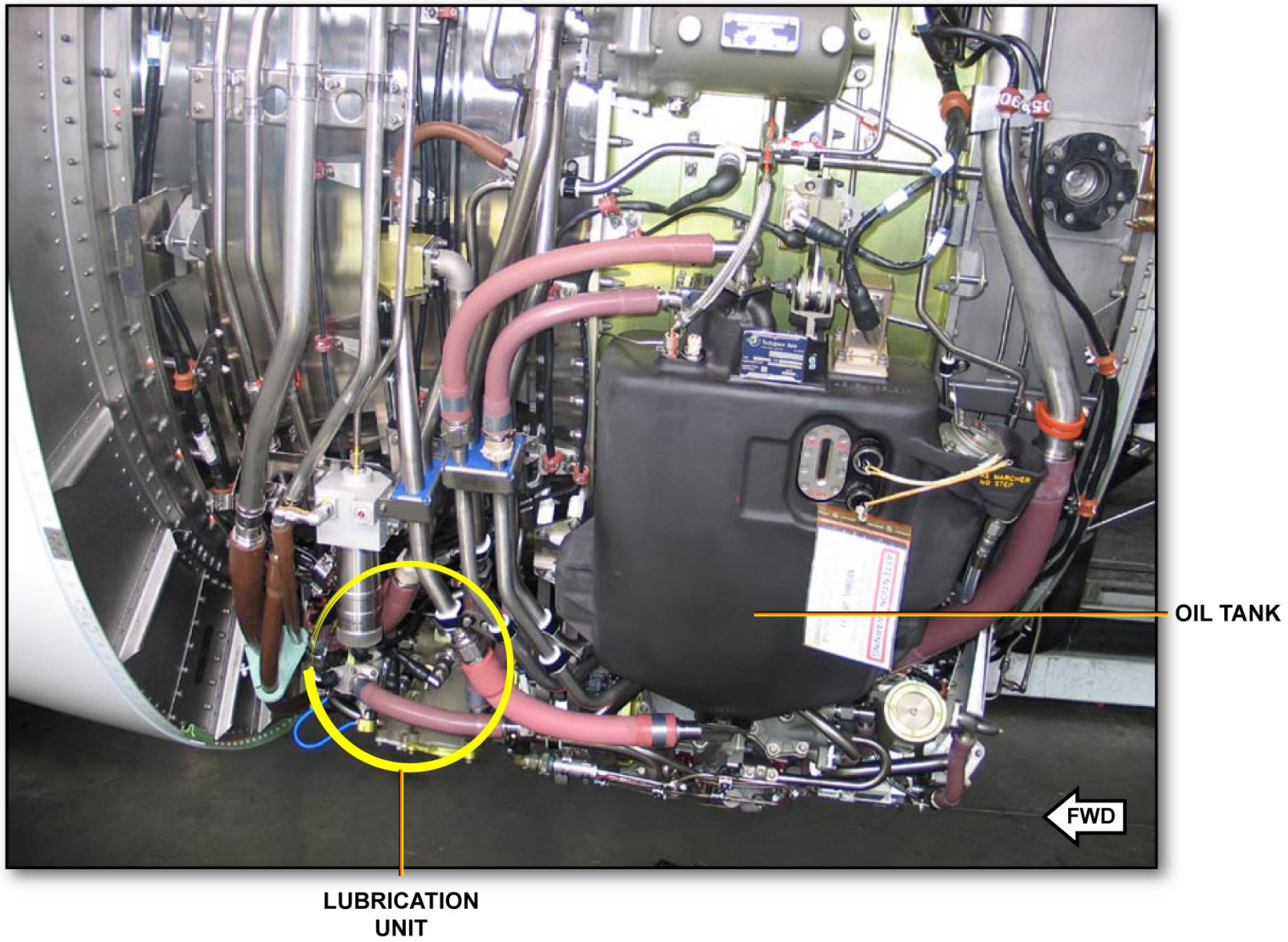
COMPONENT LOCATION - AIR

POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION (continued)

OIL

The oil tank is on the LH side of the fan case.
The lubrication unit is operated by the gearbox.



COMPONENT LOCATION - OIL

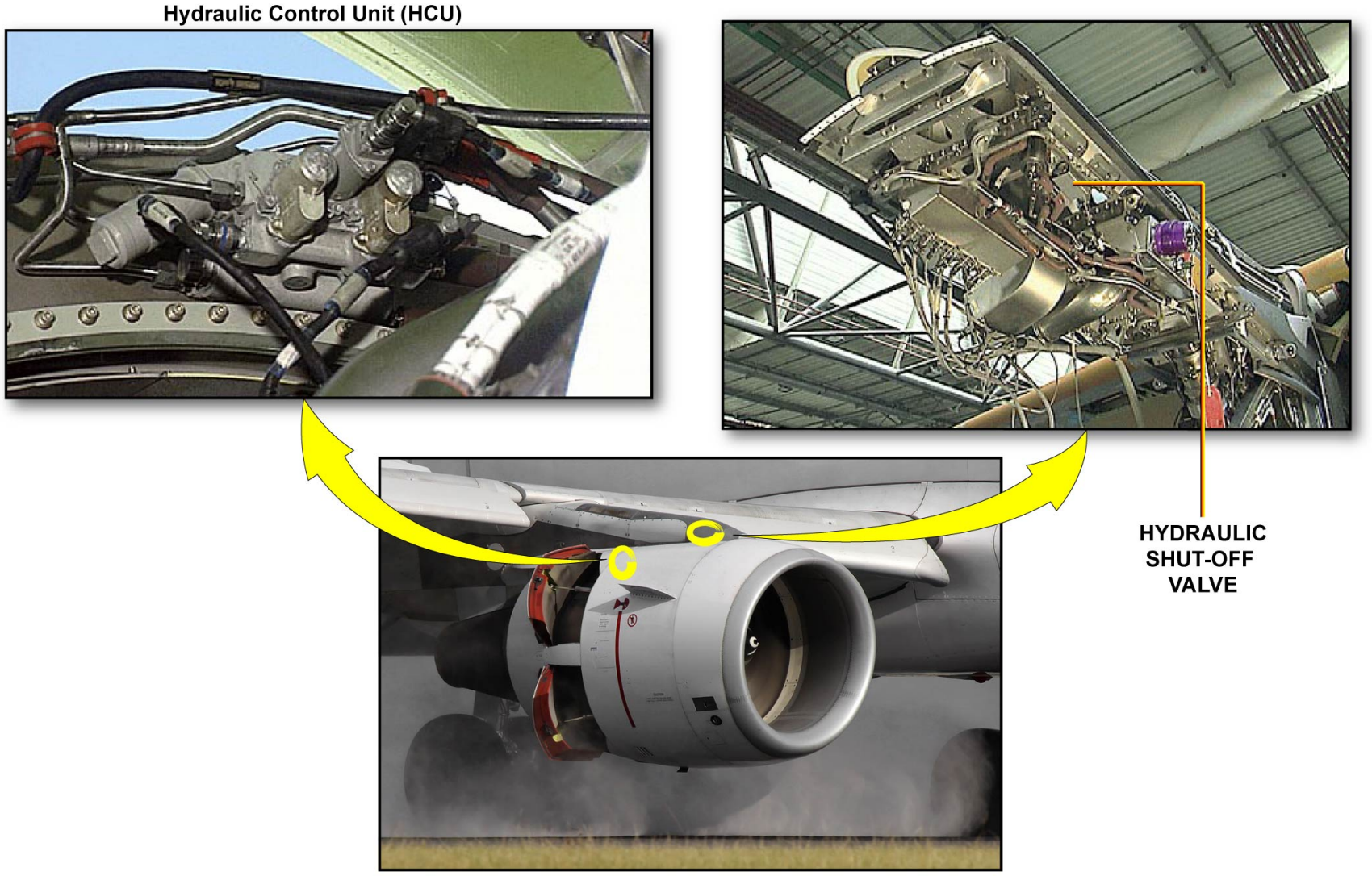
POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION (continued)

THRUST REVERSER

The hydraulic shut-off valve is on the forward part of the pylon. The HCU is installed on the forward part of the RH 'C' duct.

UG913131 - U7RT0EC - UM70C1COMPLOC01



COMPONENT LOCATION - THRUST REVERSER

ENGINE SYSTEM CONTROL & INDICATING (CFM 56) (2)

LOCATE CONTROL/INDICATING IN COCKPIT

FADEC POWERING / ENGINE CONTROLS

UG913131 - U7RT0EC - UM70IZCFMLVL202

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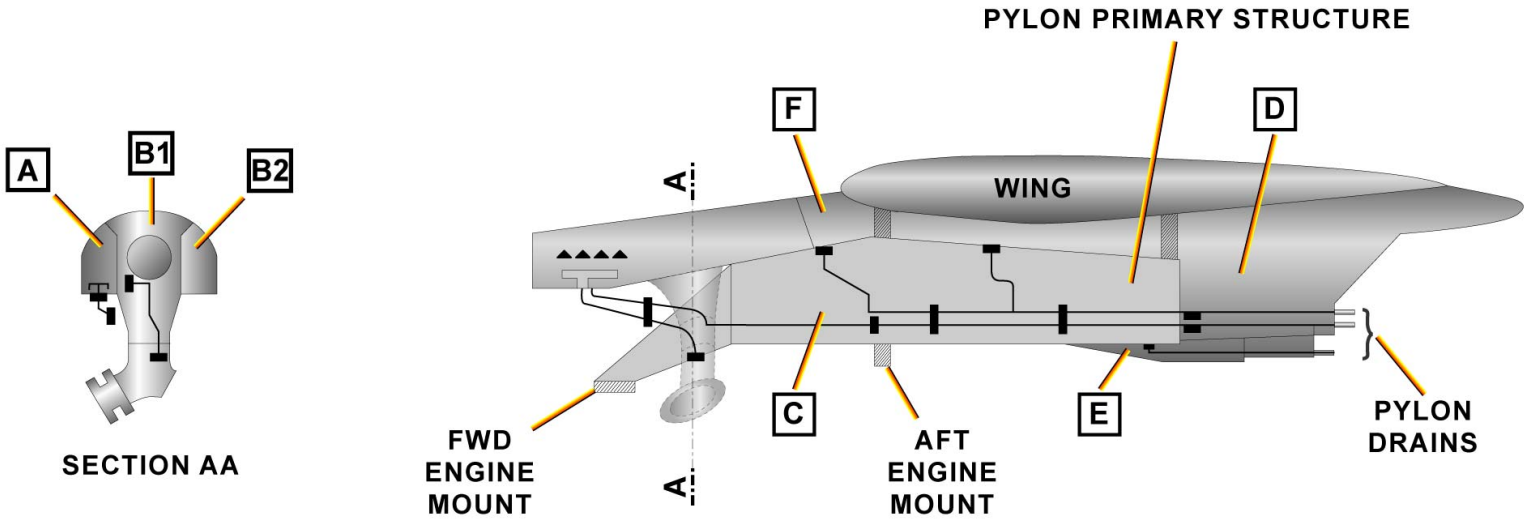
UG913131 - U7RT0EC - UM70IZCFMLVL202

POWER PLANT DRAIN PRESENTATION (2)

PYLONS DRAINS

Drains are provided at the pylon rear part to evacuate and vent overboard air and any residual fluid (water, hydraulic, fuel).

UG913131 - U7RT0EC - UM71P1CFM000001



DESIGNATION	ZONE	SYSTEMS
FORWARD FAIRING	A B1 B2	FLAMMABLE FLUIDS (FUEL, HYDRAULICS) BLEED AIR (HI AND LO TEMPERATURES) ELECTRICS
PYLON BOX	C	HYDRAULICS WITHOUT COUPLINGS FIRE EXTENGUISHER BOTTLES
REARWARD SECONDARY STRUCTURE	D	HYDRAULICS LIMITED ELECTRICS
LOWER FAIRING	E	NONE
PYLON TO WING CENTER FILLETS	F	FUEL (ZERO-LEAKAGE COUPLINGS) ELECTRICS

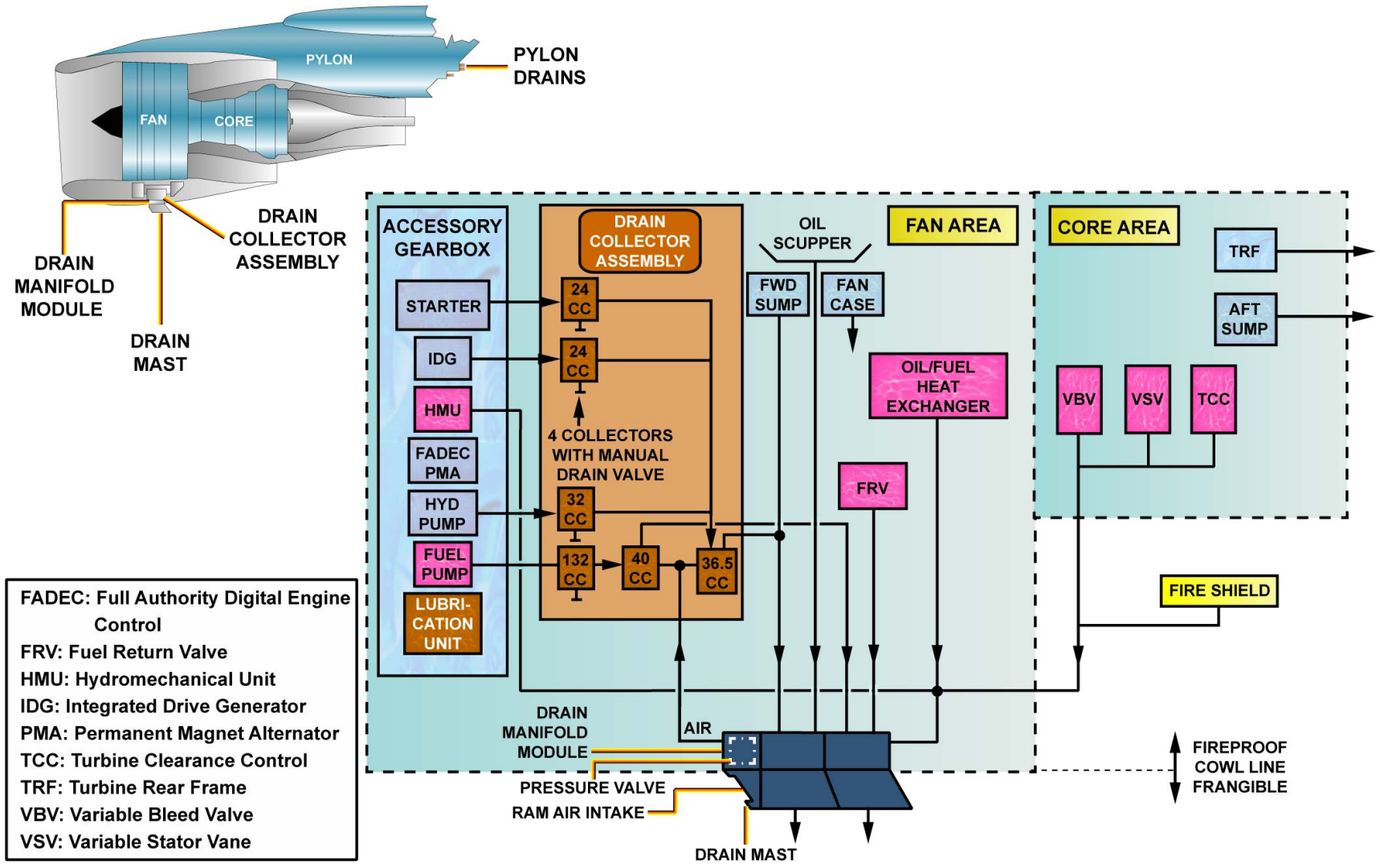
PYLONS DRAINS

POWER PLANT DRAIN PRESENTATION (2)

ENGINE DRAINS

Drain lines are installed on the engine to collect and drain waste fluids and vapors from engine systems and accessories.
This drain system consists of a drain collector assembly, which is attached to the aft side of the accessory gearbox.
It is composed of 4 drain collectors with manual drain valves for trouble shooting and 2 holding tanks.

UG913131 - U7RT0EC - UM71P1CFM000001



ENGINE DRAINS

POWER PLANT DRAIN PRESENTATION (2)

ENGINE DRAINS (continued)

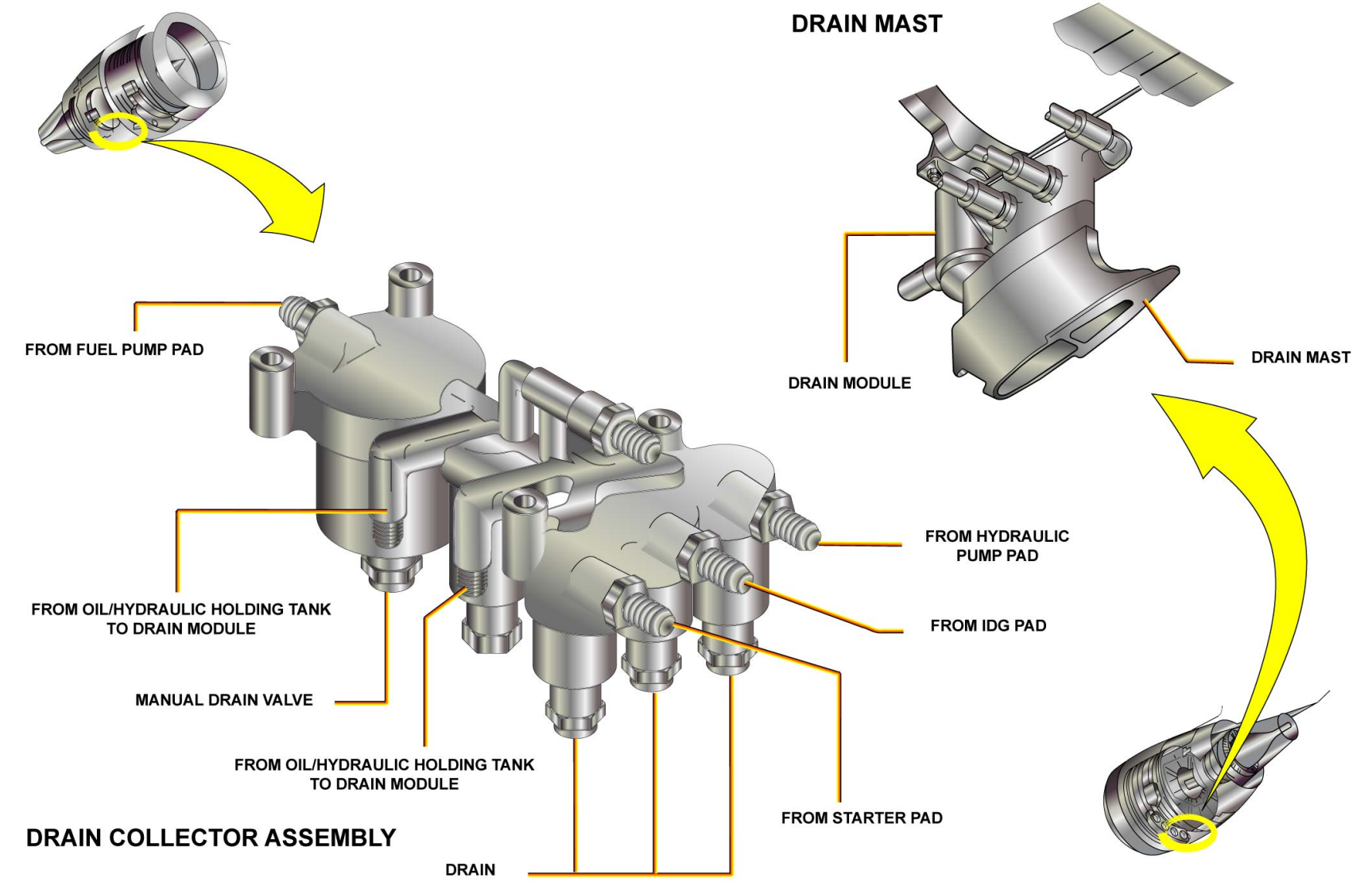
DRAIN COLLECTOR ASSEMBLY

A drain manifold module, also attached to the aft side of the accessory gearbox supports the drain mast.
A pressure valve, which is part of the manifold, opens when the A/C airspeed reaches 200 kts. Then ram air pressurizes the holding tanks and the accumulated fluids are discharged overboard through the drain mast.

DRAIN MAST

The drain mast protrudes through the fan cowl doors into the airstream to evacuate any residual fluids.
The drain mast is frangible below the cowl exterior surface to prevent damage to the engine gearbox.

UG913131 - U7RT0EC - UM71P1CFM000001

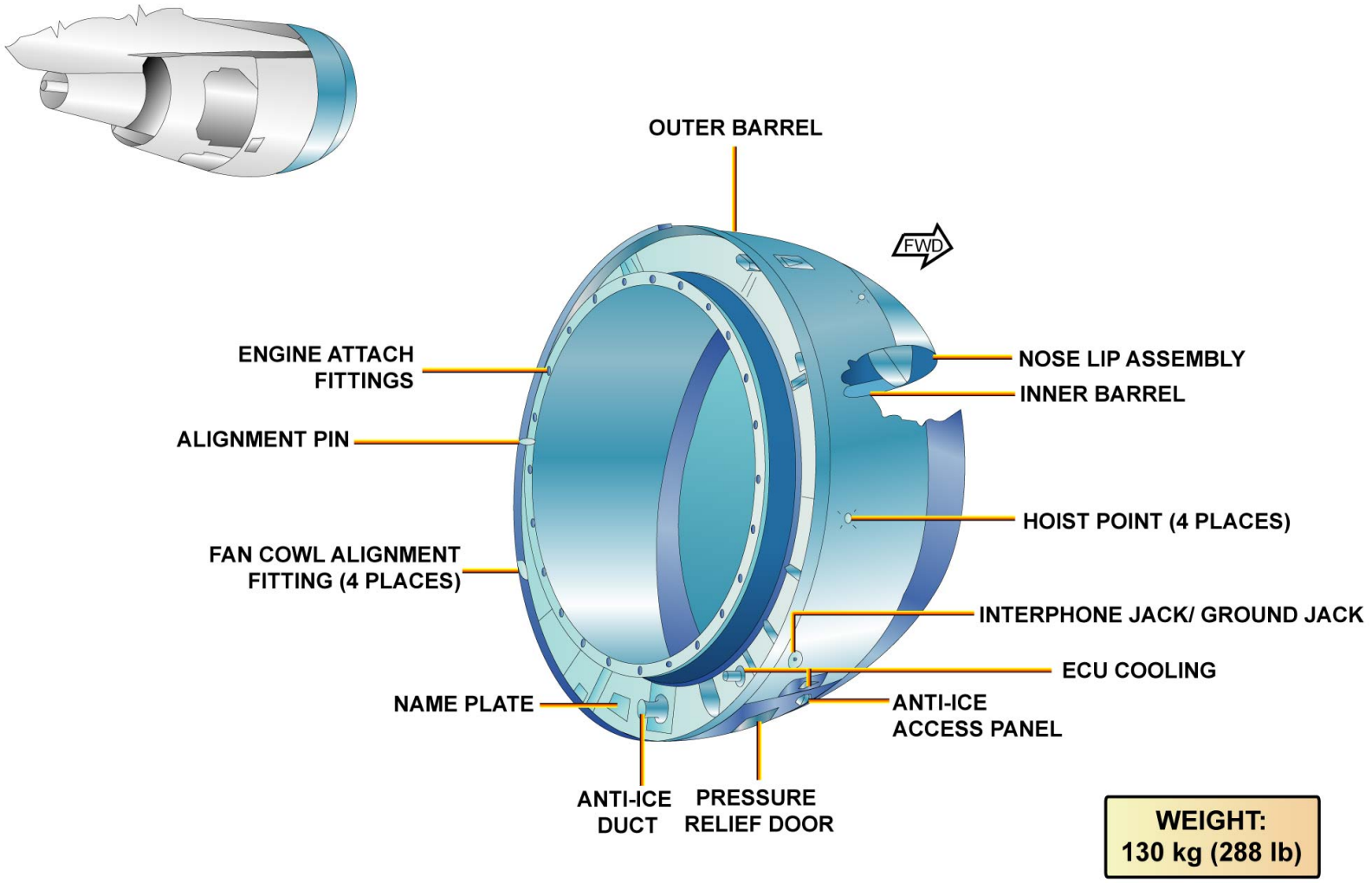


ENGINE DRAINS - DRAIN COLLECTOR ASSEMBLY & DRAIN MAST

POWER PLANT INSTALLATION D/O (3)

INLET COWL

The inlet cowl is composed of an acoustical composite inner barrel, outer barrel and a nose lip. The aluminum nose lip assembly consists of an outer lip skin and bulkhead.
It includes installation of anti-ice system, interphone and ground jack.
For removal and installation, the inlet cowl is provided with:
- 4 hoist points,
- 36 identical attach fittings,
- 1 alignment pin.


OUTER BARREL
FWD
ENGINE ATTACH FITTINGS
ALIGNMENT PIN
FAN COWL ALIGNMENT FITTING (4 PLACES)
NAME PLATE
ANTI-ICE DUCT
PRESSURE RELIEF DOOR
NOSE LIP ASSEMBLY
INNER BARREL
HOIST POINT (4 PLACES)
INTERPHONE JACK/ GROUND JACK
ECU COOLING
ANTI-ICE ACCESS PANEL
WEIGHT:
130 kg (288 lb)

INLET COWL

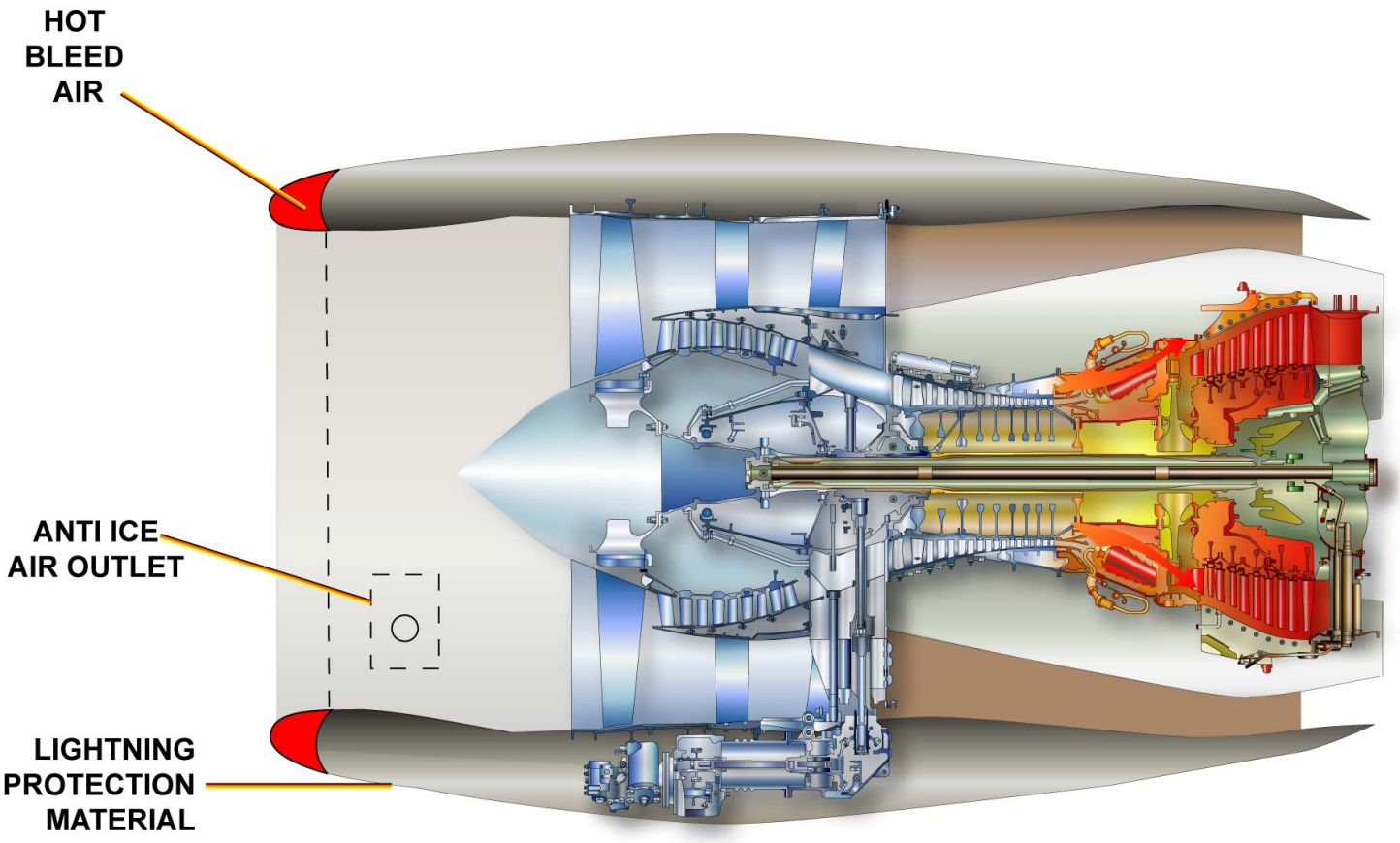
POWER PLANT INSTALLATION D/O (3)

AIR INTAKE FUNCTIONS

The main function of the inlet cowl is to guide the airflow into the engine inlet and to permit an aerodynamic airflow over the outer surface of the engine.
If engine anti icing on the cockpit overhead panel is selected to ON, then hot bleed air from the engine is ducted to the cowl nose lip to prevent ice build-up. The air then exhausts overboard through a flush exit duct in the outer barrel.
Longitudinal and transverse loads are distributed into the fan case forward flange through a bolted joint. These loads are due to:
- the air intake structure own inertia as well as,
- any internal or external loads not taken in hoop tension through the inner barrel skins.

It incorporates a lightning protection system.

UG913131 - U7RT0EC - UM71D1CFM000001



AIR INTAKE FUNCTIONS

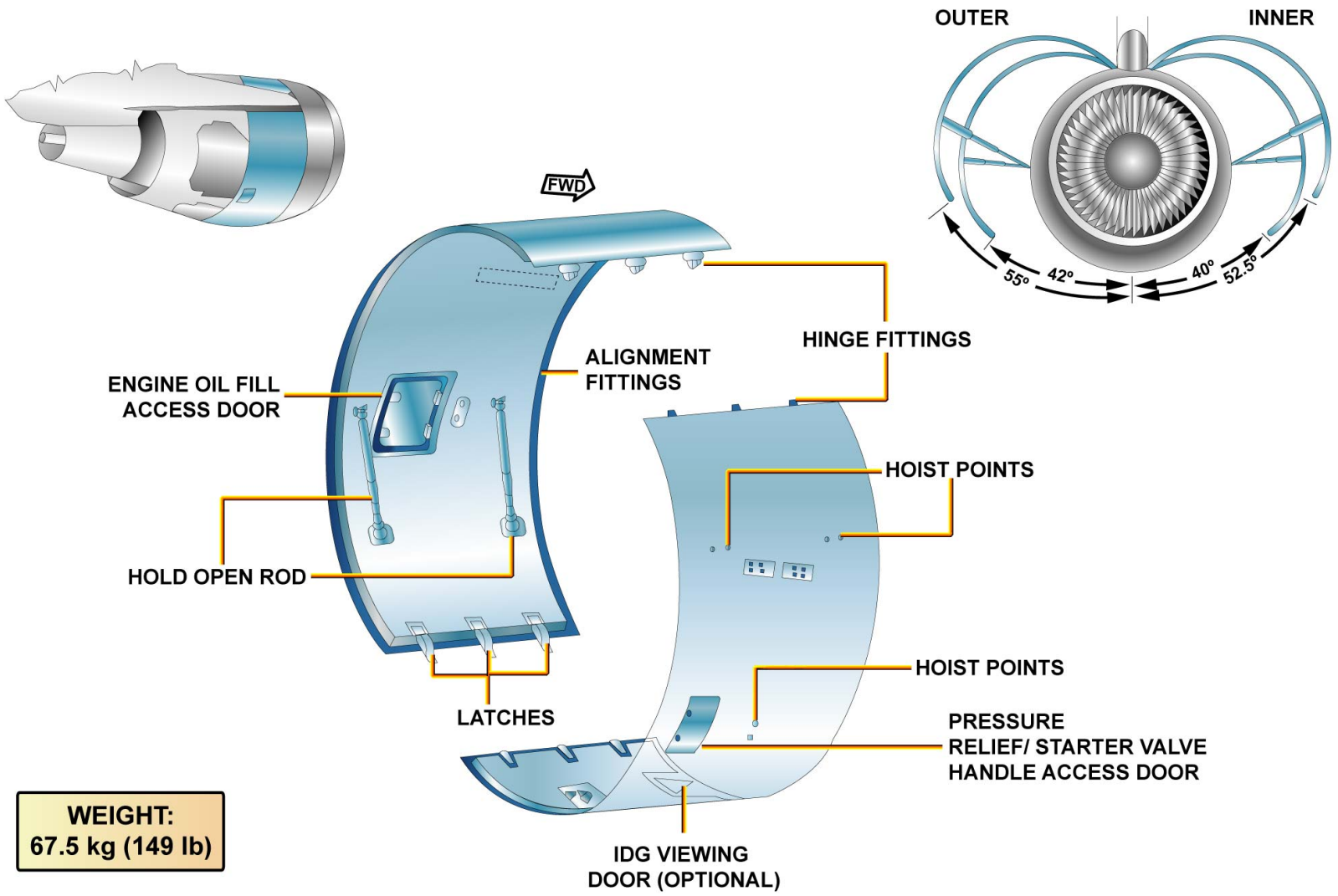
POWER PLANT INSTALLATION D/O (3)

FAN COWL DOORS

There are two fan cowl doors to enclose the fan case and accessory gearbox area.
Each door is supported by 3 hinges at the pylon.
The door assembly is latched along the bottom centerline by three latches.
Each door is provided with:
- 3 hoist points, for removal and installation,
- 2 hold open rods, for opening.

Access doors are also provided for the start valve and the oil tank servicing.
An optional Integrated Drive Generator (IDG) viewing door can be provided to check the IDG oil level.

UG913131 - U7RT0EC - UM71D1CFM000001



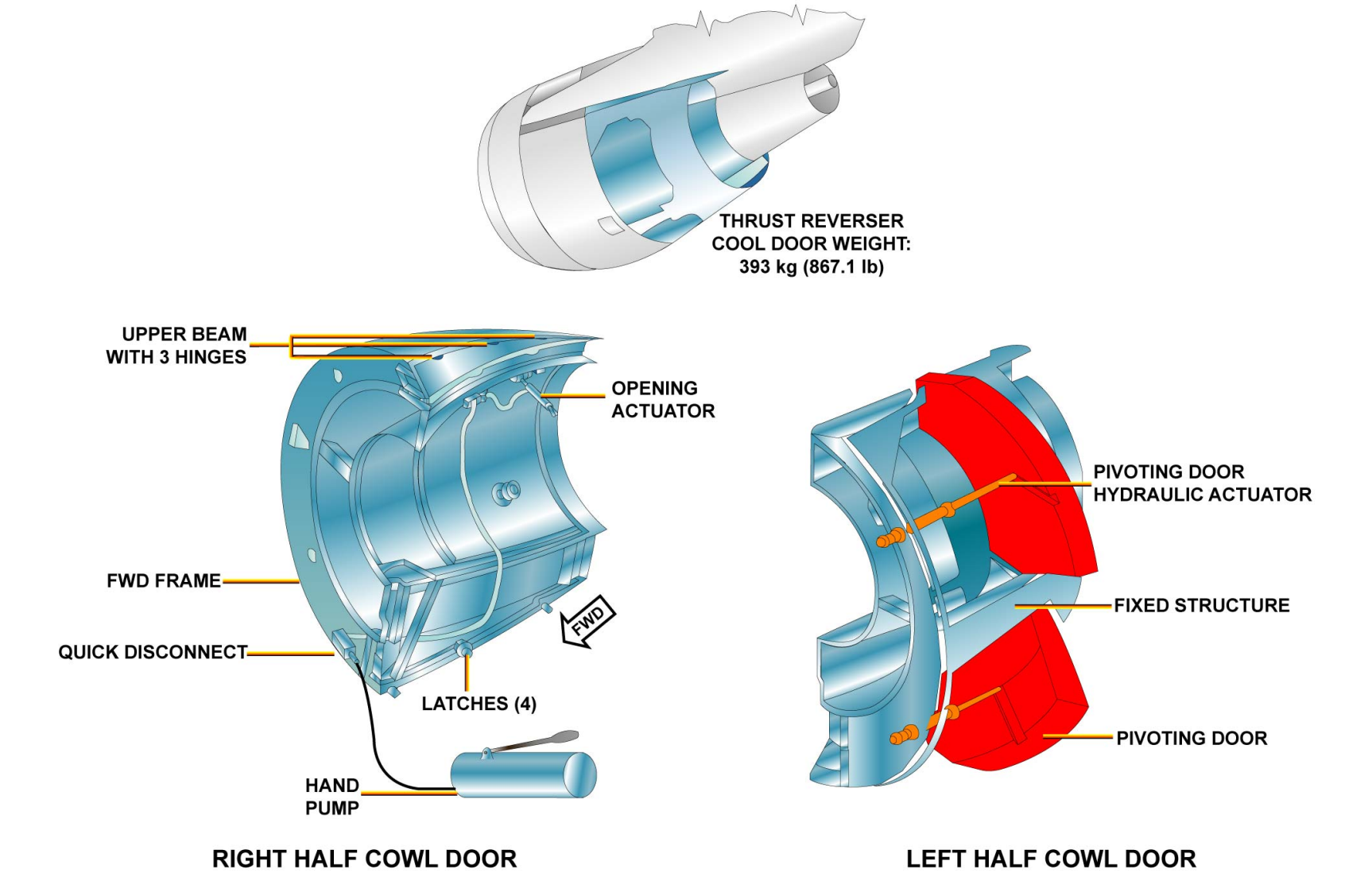
FAN COWL DOORS

POWER PLANT INSTALLATION D/O (3)

THRUST REVERSER COWL DOORS

The thrust reverser cowl doors (or "C" Ducts) are in two halves which include pivoting doors and enclose the engine core area.
Each half is supported by 3 hinges at the pylon. The assembly is latched along the bottom centerline by 4 latches.
Each half is provided with:
- 3 attachment points to install a handling sling for removal and installation,
- 1 opening actuator supplied by a hand pump and 1 hold open rod mounted on the fan case for opening.

UG913131 - U7RT0EC - UM71D1CFM000001



THRUST REVERSER COWL DOORS

POWER PLANT INSTALLATION D/O (3)

THRUST REVERSER COWL DOORS (continued)

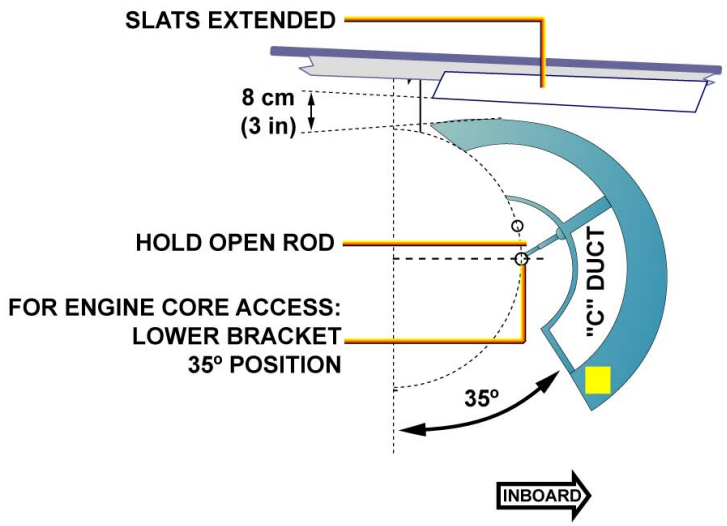
THRUST REVERSER COWL DOOR OPENING

Note that the thrust reverser half doors can be opened to a 45 degrees position for engine removal. In the case the inboard Cowl is opened to 45°, the wing slats have to be in the retracted position.
For normal access to the engine core components, the thrust reverser half doors can be opened at 35 degree with the slats in extended position.

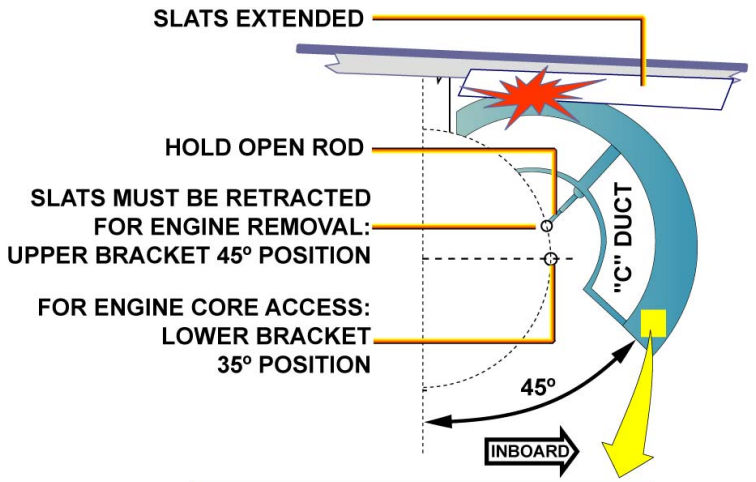
NOTE: The gap clearance between the Extended SLATS and the 35 degree opened inboard Cowl is approximately of 8 cm or 3 in.

UG913131 - U7RT0EC - UM71D1CFM000001

NORMAL OPENING PROCEDURE



ENGINE REMOVAL OPENING PROCEDURE



WARNING

THRUST REVERSER COWL
OPENING INSTRUCTIONS :

INBOARD COWL

NORMAL OPENING 35°
ENGINE INSTALLATION / REMOVAL : 45°
(SLATS MUST BE RETRACTED / INHIBITED)

OUTBOARD COWL:

OPENING AT 35° or 45° WITHOUT RESTRICTION

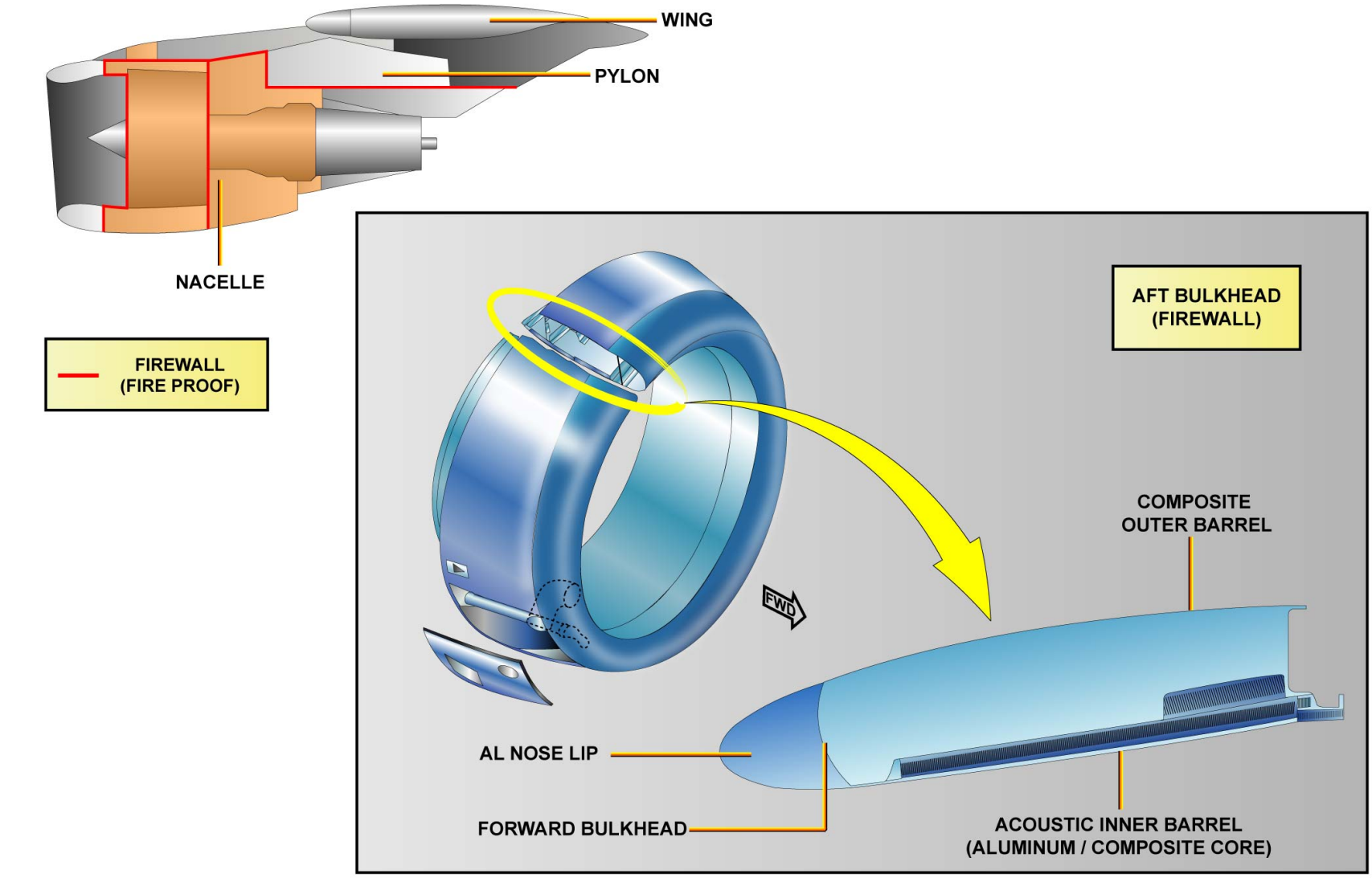
THRUST REVERSER COWL DOORS - THRUST REVERSER COWL DOOR OPENING

POWER PLANT INSTALLATION D/O (3)

FIREWALLS AND ACOUSTIC PANELS

Fire protection:
Firewalls and fire seals provide segregation and fire protection between the engine compartments (fan and core compartments). The fire seals separate the space within the engine into compartments.
This means of isolation limits propagation, should a fire occur. The pylon floor forms the upper firewall of both the fan and core compartments.
Acoustic treatment:
The inner barrel in the air intake cowl consists of three acoustically treated structural bonded panels, which are assembled with mechanical fasteners and attached to an engine attach ring.
The inner barrel in the thrust reverser structure is also acoustically treated and consists of aluminum perforated face sheet bonded to aluminum honeycomb core.

UG913131 - U7RT0EC - UM71D1CFM000001



FIREWALLS AND ACOUSTIC PANELS

POWER PLANT INSTALLATION D/O (3)

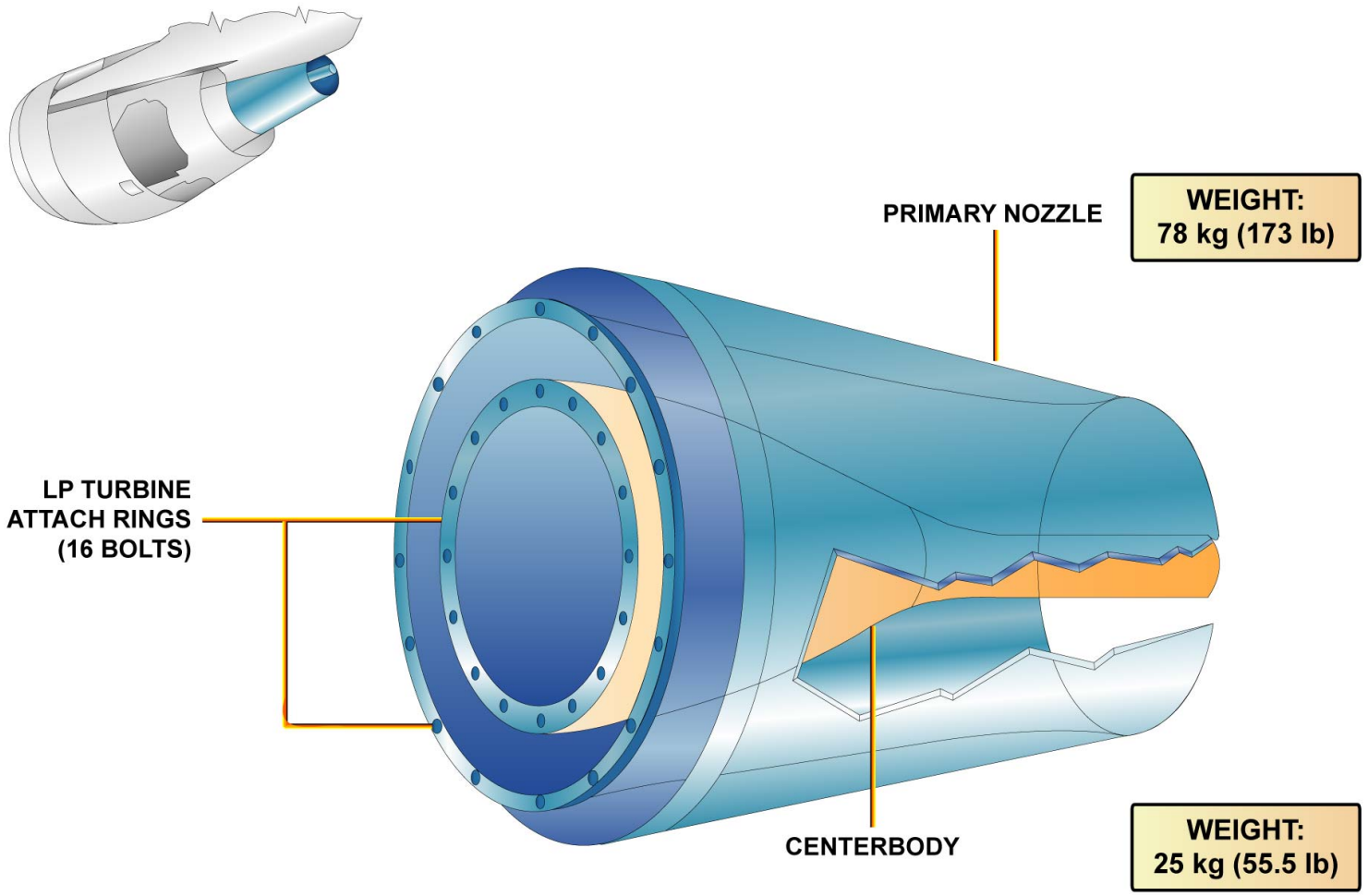
PRIMARY NOZZLE

The primary nozzle directs the primary exhaust gas aft and regulates the gas stream flow.
It is fastened to the aft flange of the engine turbine case.
The primary nozzle is attached to the Low Pressure Turbine (LPT) frame by means of 16 bolts.

CENTERBODY

The centerbody provides engine center venting.
It is attached to the engine inner turbine case.
The centerbody is fixed to the inner LPT frame by means of 16 bolts.

UG913131 - U7RT0EC - UM71D1CFM000001



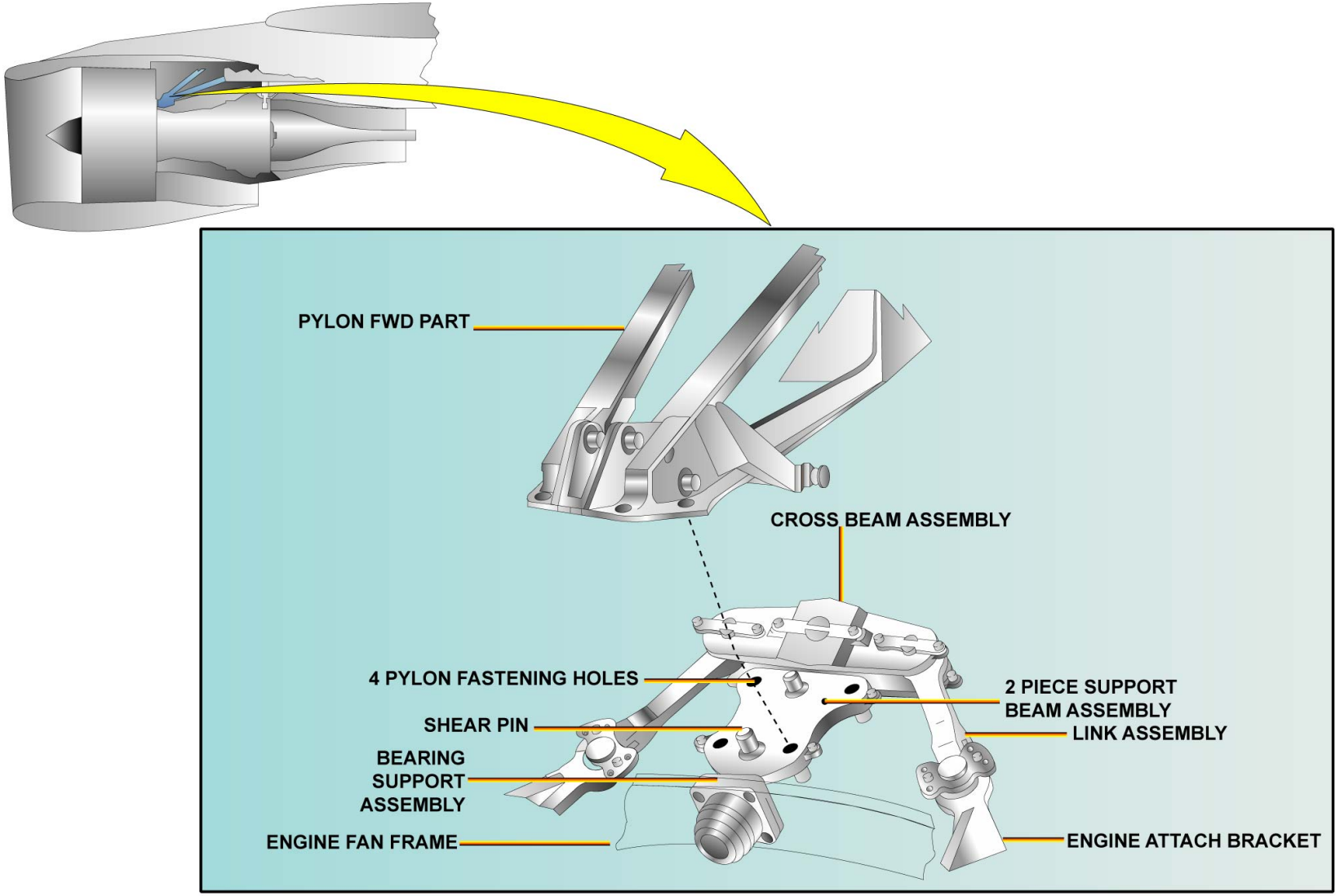
PRIMARY NOZZLE & CENTERBODY

POWER PLANT INSTALLATION D/O (3)

FORWARD MOUNT

The forward mount carries the engine thrust, vertical and side loads. It provides the fan frame attachment to the pylon.
The forward mount is linked to the fan frame brackets and attached to the pylon by four bolts and self-locking nuts.

UG913131 - U7RT0EC - UM71D1CFM000001



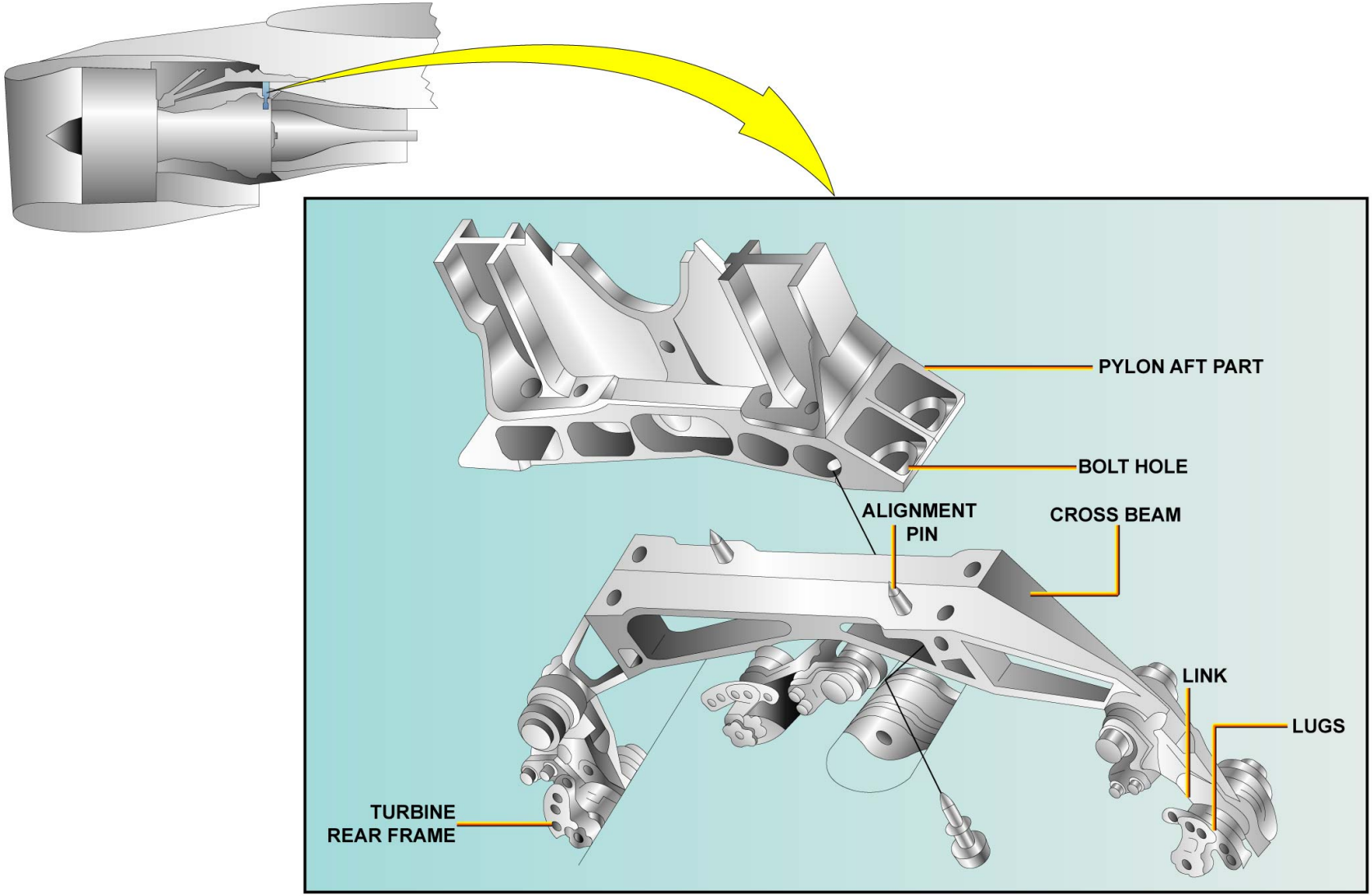
FORWARD MOUNT

POWER PLANT INSTALLATION D/O (3)

AFT MOUNT

The aft mount restrains engine movement in all directions except forward and aft. It provides the turbine rear frame attachment to the pylon. The aft mount is linked to the turbine rear frame lugs and fixed to the pylon by 4 bolts.

UG913131 - U7RT0EC - UM71D1CFM000001


PYLON AFT PART
BOLT HOLE
ALIGNMENT PIN
CROSS BEAM
LINK
LUGS
TURBINE REAR FRAME

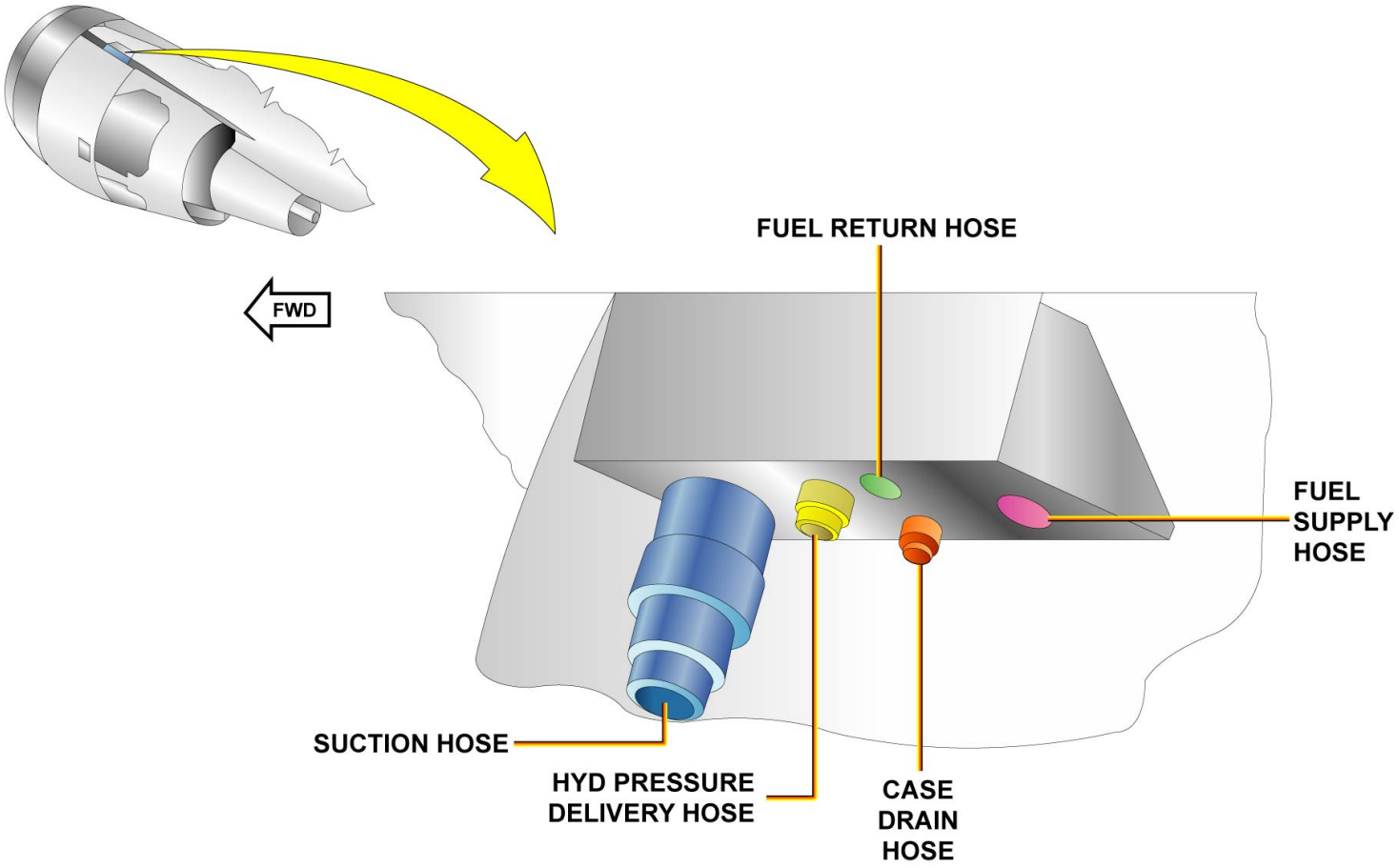
AFT MOUNT

POWER PLANT INSTALLATION D/O (3)

FLUID DISCONNECT PANEL

The fluid disconnect panel provides the fluid connection between engine and pylon.
It is located on the LH side of the fan case upper part.
Fluid connection lines:
- fuel supply,
- fuel return,
- hydraulic pump suction,
- hydraulic pump pressure delivery,
- case drain filter.

UG913131 - U7RT0EC - UM71D1CFM000001



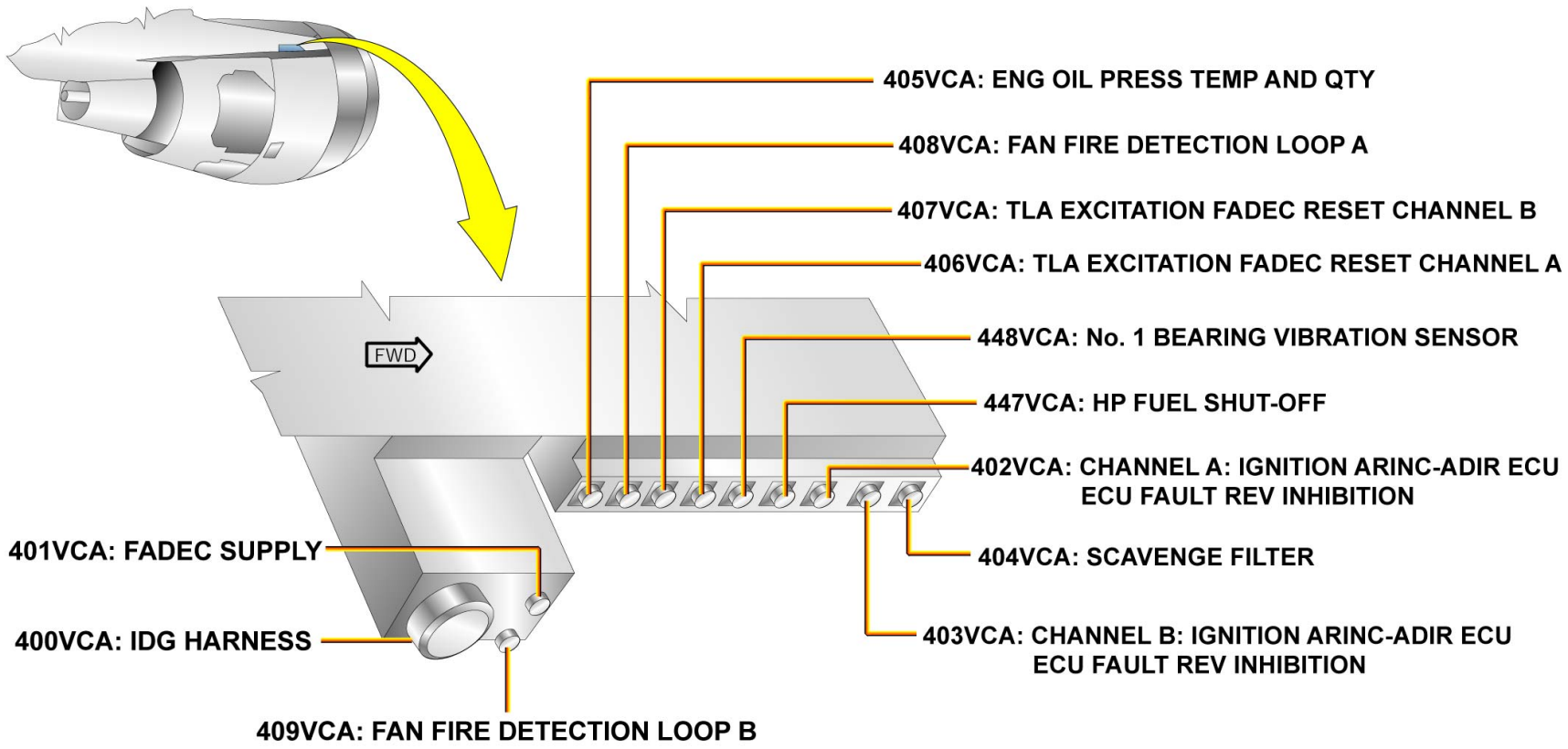
FLUID DISCONNECT PANEL

POWER PLANT INSTALLATION D/O (3)

FAN ELECTRICAL CONNECTOR PANEL

The fan electrical connector panel provides interface of fan electrical harnesses with the pylon.
It is located on the RH side of the fan case upper part.

UG913131 - U7RT0EC - UM71D1CFM000001


405VCA: ENG OIL PRESS TEMP AND QTY
408VCA: FAN FIRE DETECTION LOOP A
407VCA: TLA EXCITATION FADEC RESET CHANNEL B
406VCA: TLA EXCITATION FADEC RESET CHANNEL A
448VCA: No. 1 BEARING VIBRATION SENSOR
447VCA: HP FUEL SHUT-OFF
402VCA: CHANNEL A: IGNITION ARINC-ADIR ECU
ECU FAULT REV INHIBITION
404VCA: SCAVENGE FILTER
403VCA: CHANNEL B: IGNITION ARINC-ADIR ECU
ECU FAULT REV INHIBITION
401VCA: FADEC SUPPLY
400VCA: IDG HARNESS
409VCA: FAN FIRE DETECTION LOOP B
FWD

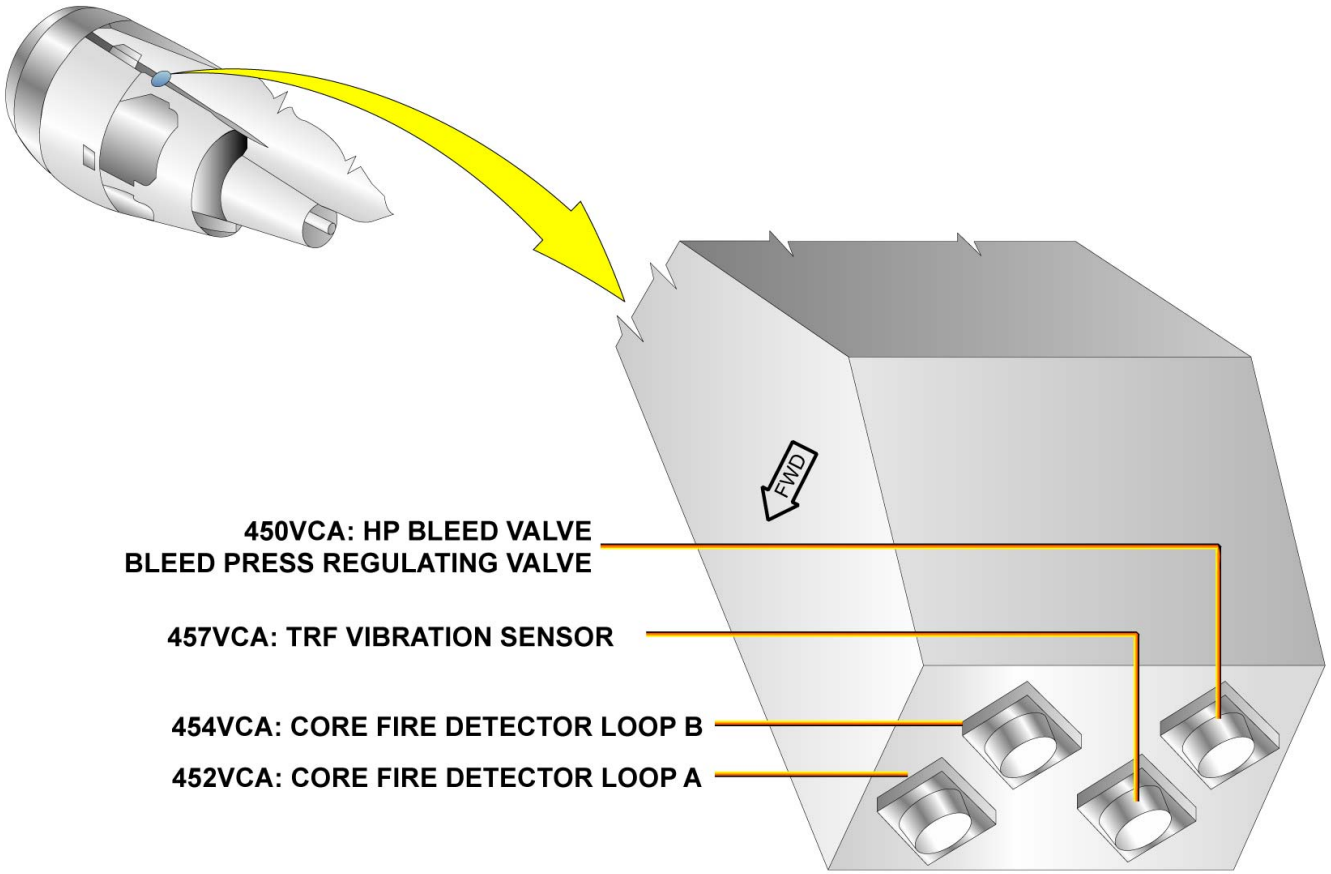
FAN ELECTRICAL CONNECTOR PANEL

POWER PLANT INSTALLATION D/O (3)

CORE ELECTRICAL JUNCTION BOX

The core electrical junction box provides interface of core electrical harnesses with the pylon.
It is located in the zone of the forward mount.

UG913131 - U7RT0EC - UM71D1CFM000001

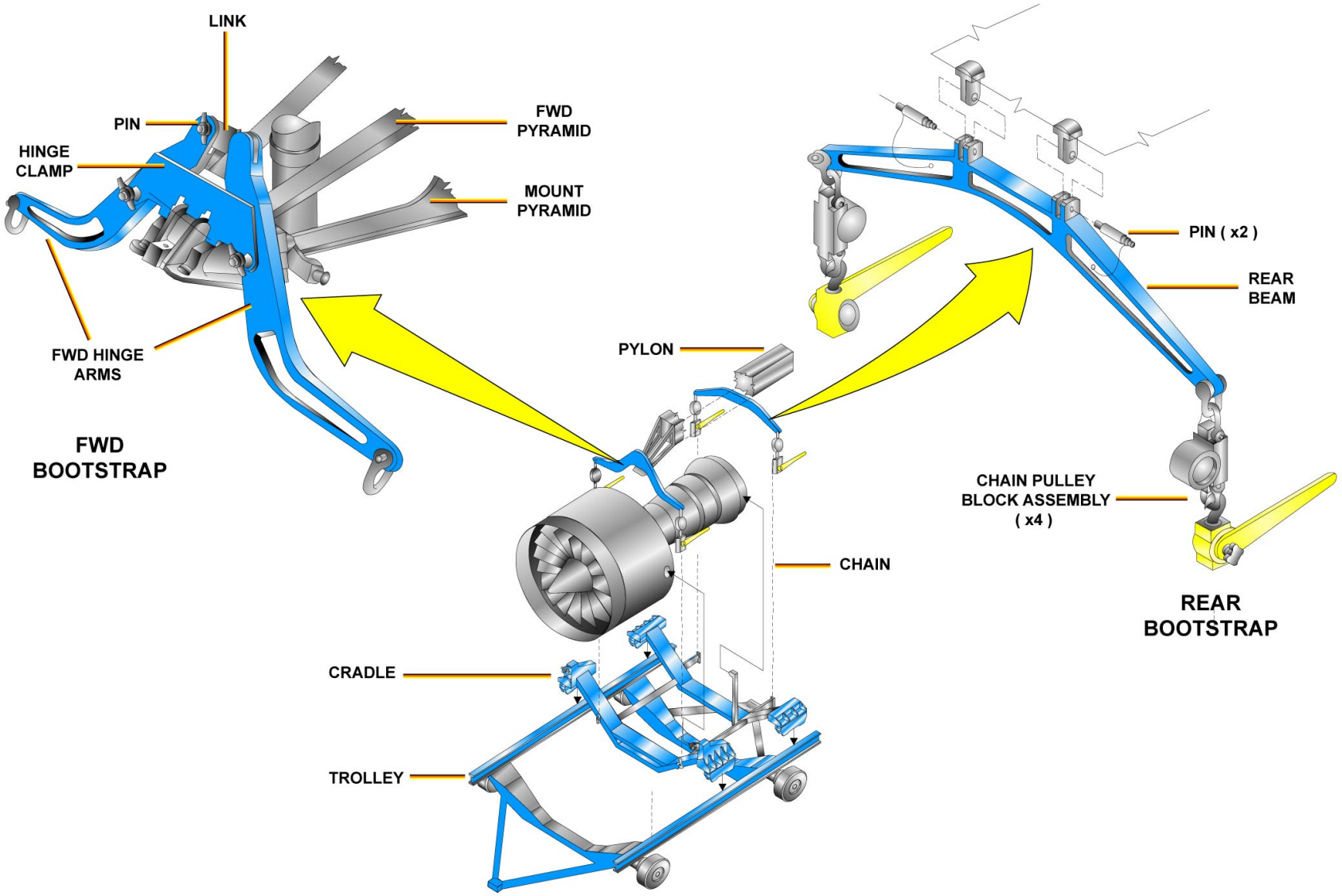

FWD
450VCA: HP BLEED VALVE
BLEED PRESS REGULATING VALVE
457VCA: TRF VIBRATION SENSOR
454VCA: CORE FIRE DETECTOR LOOP B
452VCA: CORE FIRE DETECTOR LOOP A

CORE ELECTRICAL JUNCTION BOX

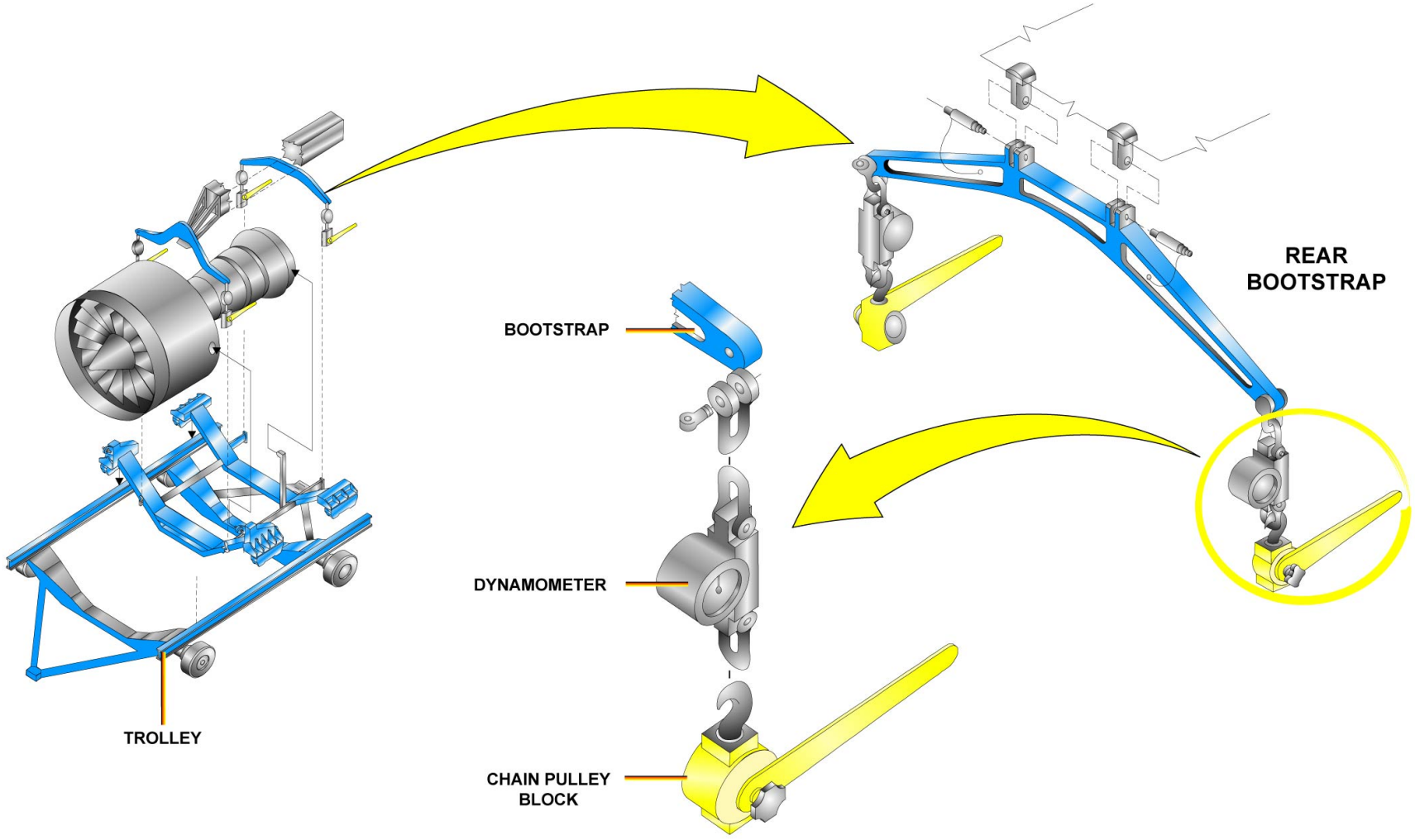
POWER PLANT INSTALLATION D/O (3)

BOOTSTRAP SYSTEM INSTALLATION

The removal and installation of the engine requires the installation of a bootstrap system on the aircraft pylon. The bootstrap system is composed of two elements, to be installed at the front and at the rear of the pylon. Each element permits to attach at its ends the chain pulley blocks assembly and dynamometers that are used to lower or to lift the transportation stand attached to the engine.



BOOTSTRAP SYSTEM INSTALLATION



BOOTSTRAP SYSTEM INSTALLATION

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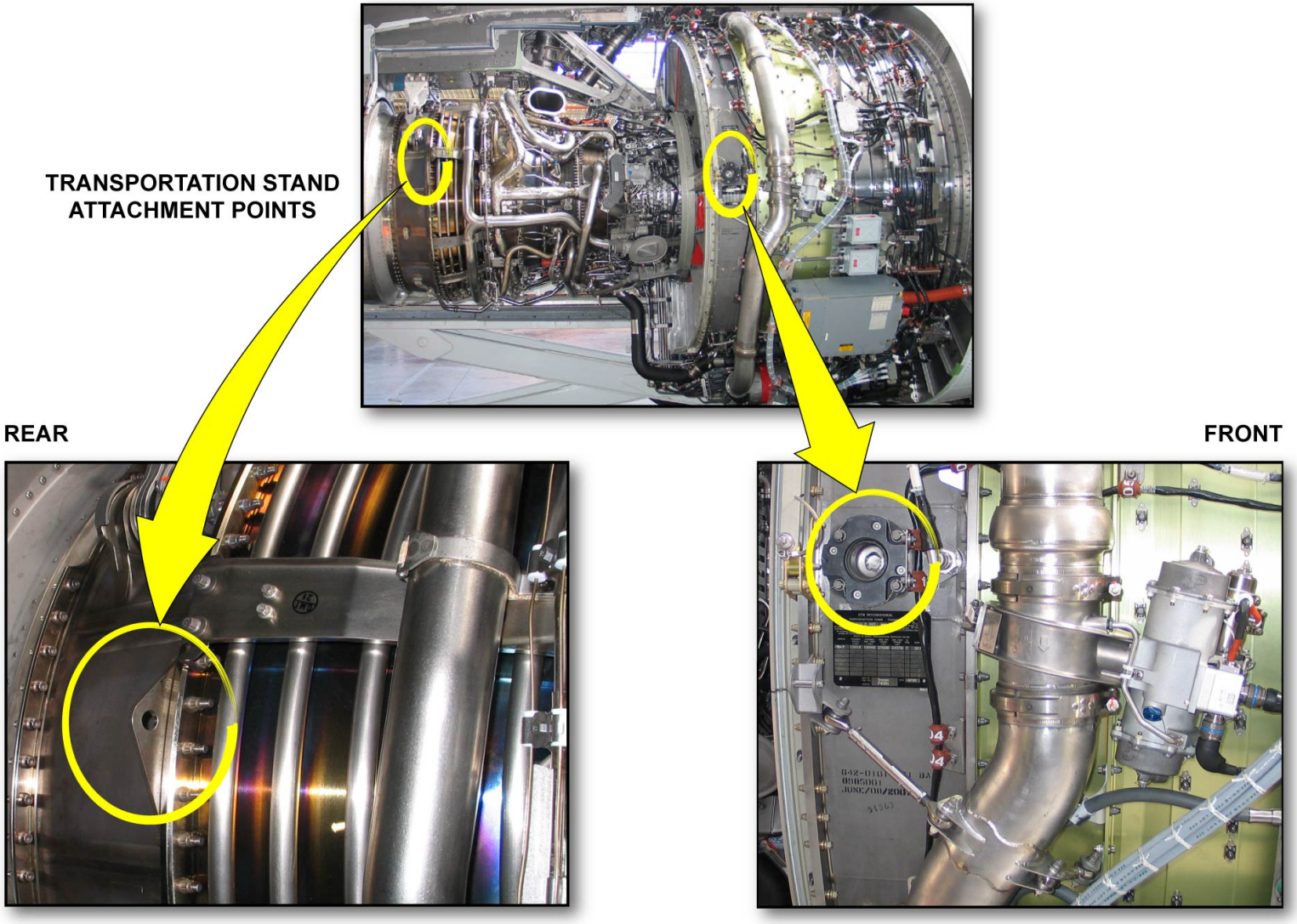
UG913131 - U7RT0EC - UM71D1CFM000001

POWER PLANT INSTALLATION D/O (3)

ENGINE TRANSPORTATION STAND ATTACHMENT POINTS

The engine transportation stand, which is used for engine removal and installation, can be fixed to the engine by means of four trunnions:
- two front trunnions fixed on the LP compressor case, LH side and RH side,
- two rear trunnions fixed on the LP turbine case, LH side and RH side.



ENGINE TRANSPORTATION STAND ATTACHMENT POINTS

ENGINE SYSTEM D/O (3)

ENGINE CHARACTERISTICS

The Airbus A320 family is powered by two CFM International CFM56-5 turbofan engines.
These engines can produce a thrust from 21600 lb (9800 kg) to 33000 lb (14970 kg) depending on the aircraft version set by the engine data programming plug.
The CFM56-5B/3 Tech Insertion propulsion system is a modified version of the CFM56-5B/P current production propulsion system, by incorporation of some TECH56 technologies developed by CFM.

PYLON

The engines are attached to the lower surface of the wings by pylons. The pylons provide an interface between the engine and the aircraft for electrics, fluids, pneumatics and mechanical forces.

NACELLE

The engine is enclosed in a nacelle, which provides aerodynamic airflow around the engine and ensures protection for the accessories.

ENGINE CONTROL

The engine includes a Full Authority Digital Engine Control (FADEC) system consisting of the Engine Control Unit (ECU) with two independent channels, sensors, actuators and other peripheral components on the engine. The FADEC system provides engine control, engine monitoring and help for maintenance and trouble shooting.

UG913131 - U7RT0EC - UM72D1CFM000001

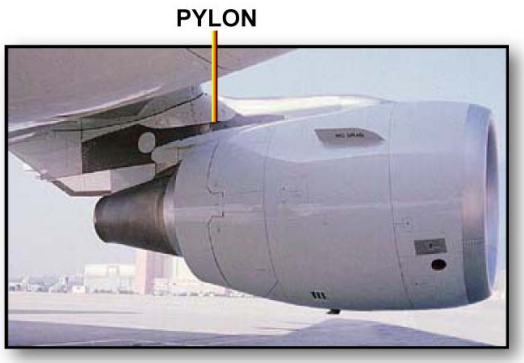
CFM56 - 5Bx

(1 TO 9) THRUST RATING : 21600 lb
(9800 kg)
: 33000 lb
(14970 kg)

FOR POWERING OF
A320 FAMILY

TECH INSERTION Technology

CFM56-5Bx/3: Higher efficiency applicable
to all thrust ratings



ENGINE CHARACTERISTICS - PYLON ... ENGINE CONTROL

ENGINE SYSTEM D/O (3)

ENGINE GENERAL PARAMETERS

There is a different kind of thrust depending on the engine installed on the aircraft. Until 33000 lb (14970 kg) can be achieved during take off with the CFM56-5B3 on A321, or 21600 lb (9800 kg) with CFM56-5B8 on A318, which is the lowest take-off thrust. Notice the take-off thrust is the same between the CFM56-5B4 on A320 and CFM56-5B7 on A319 and A319 Corporate Jet, with a thrust value of 27000 lb (12250 kg).

UG913131 - U7RT0EC - UM72D1CFM000001

ENGINE PARAMETERS

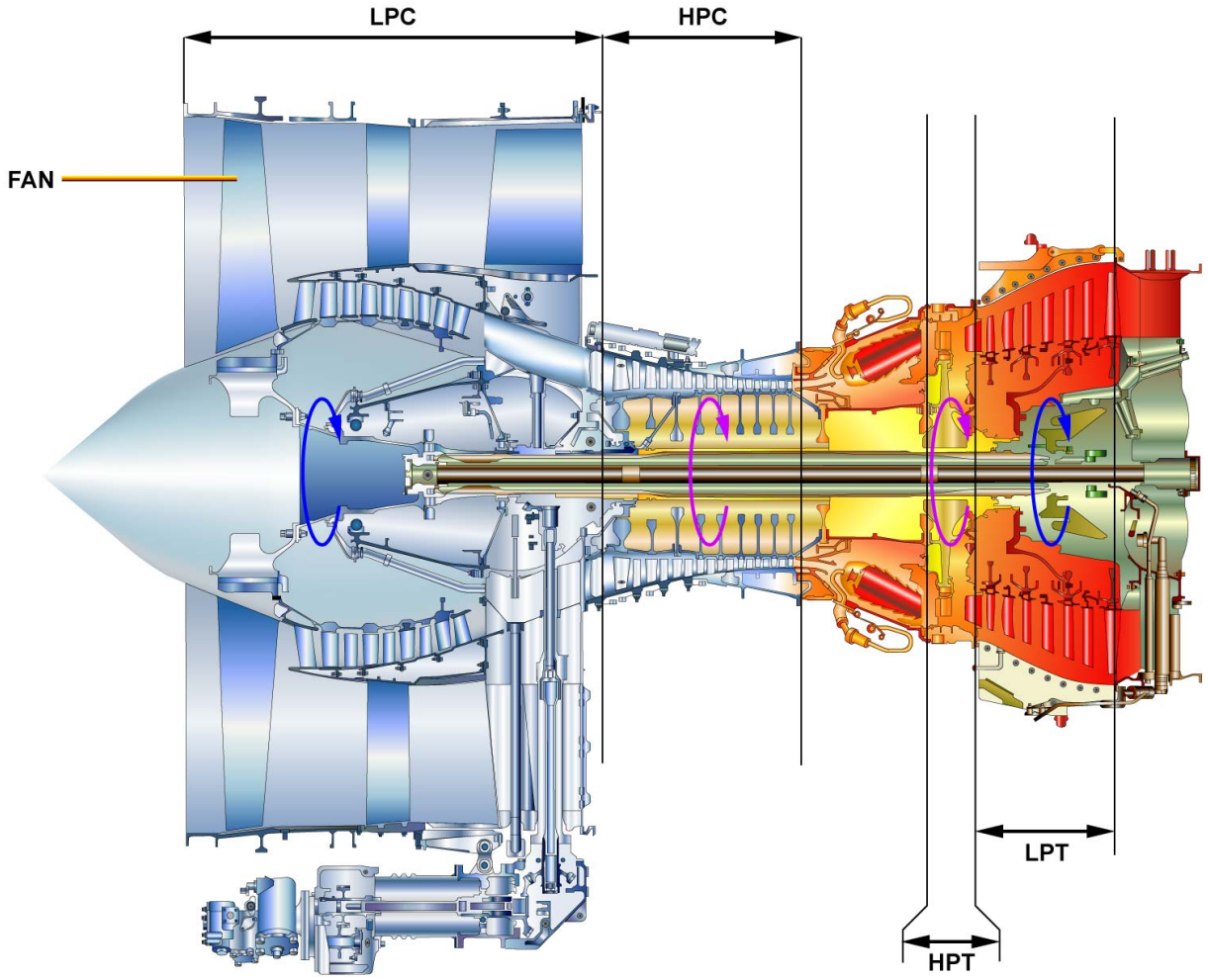
TAKEOFF CONDITIONS (SEA LEVEL)		CFM56-5B1	-5B2	-5B3	-5B4	-5B5	-5B6	-5B7	-5B8	-5B9
- MAX. TAKEOFF	(lb)	30000	31000	33000	27000	22000	23500	27000	21600	23300
	(kg)	13610	14060	14970	12250	9980	10660	12250	9800	10570
- AIRFLOW	(lb/s)	943	956	968	897	818	844	897	811	841
	(kg/s)	428	420	439	407	371	383	407	368	381
- BYPASS RATIO		5.5	5.5	5.4	5.7	6.0	5.9	5.7	6.0	5.9
IN-FLIGHT PERFORMANCE (INSTALLED) (35000 ft - MACH=0.80 -ISA)		**-5B1**	**-5B2**	**-5B3**	**-5B4**	**-5B5**	**-5B6**	**-5B7**	**-5B8**	**-5B9**
- MAX. CLIMB THRUST	(lb)	6420	6420	6420	5630	5630	5630	6420	5630	5630
	(kg)	2912	2912	2912	2554	2554	2554	2912	2554	2554
- OVERALL PRESSURE RATIO AT MAX. CLIMB		35.4	35.4	35.5	32.6	32.6	32.6	35.5	32.6	32.6
- MAX. CRUISE THRUST	(lb)	5840	5840	5840	5020	5020	5020	5840	5020	5020
	(kg)	2649	2649	2649	2277	2277	2277	2649	2277	2277
ENGINE CHARACTERISTICS		**- 5B1**	**-5B2**	**-5B3**	**-5B4**	**-5B5**	**-5B6**	**-5B7**	**-5B8**	**-5B9**
- LENGTH (in)		102.4	102.4	102.4	102.4	102.4	102.4	102.4	102.4	102.4
- FAN DIAMETER (in)		68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3
- BASIC DRY WIGHT	(lb)	5250	5250	5250	5250	5250	5250	5250	5250	5250
	(kg)	2381	2381	2381	2381	2381	2381	2381	2381	2381
APPLICATIONS		A321	A321	A321	A320	A319	A319	A319 A319CJ	A318	A318

ENGINE GENERAL PARAMETERS

ENGINE SYSTEM D/O (3)

TURBINE OPERATION

The turbine rotor is the mechanical part that provides energy to the compressor shaft. This energy is delivered to the turbine rotor by the gases from the combustion chambers. These gases deliver their energy in the turbine blades forcing the turbine rotor to turn.



TURBINE OPERATION

ENGINE SYSTEM D/O (3)

ENGINE BEARINGS

The engine rotors are supported by bearings installed in the two sump cavities. The forward sump is in the fan frame and is the location of bearings No.1, No.2 (fan/booster shaft) and No. 3 (High Pressure (HP) shaft).
The aft sump is in the turbine rear frame where are bearings No.4 for the HP shaft aft and No.5 for the LP shaft.
Bearings provide reduced rolling friction, support the rotors axially and radially within the engine structure, and position the rotors relative to the stators. The bearing must control the forces of gravity weight, aerodynamic loads of pumping and turbine driving and gyroscopic loads due to aircraft maneuvers.

NO.1 AND NO.2 BEARING

The No.1 ball bearing is a thrust bearing which carries the axial loads generated by the LP rotor system.
The No.2 roller bearing takes the radial loads from the fan and booster rotor.

NO.3 BEARING

The inlet gearbox assembly contains a core engine thrust bearing, and a core engine roller bearing.

NO.4 AND NO.5 BEARING

The No.4 bearing, which takes the High Pressure Turbine (HPT) rotor radial loads, is a roller bearing installed between the HPT rear shaft and the Low Pressure Turbine (LPT) shaft.
The No.5 bearing supports the LPT rotor aft end inside the turbine frame and takes the radial loads.

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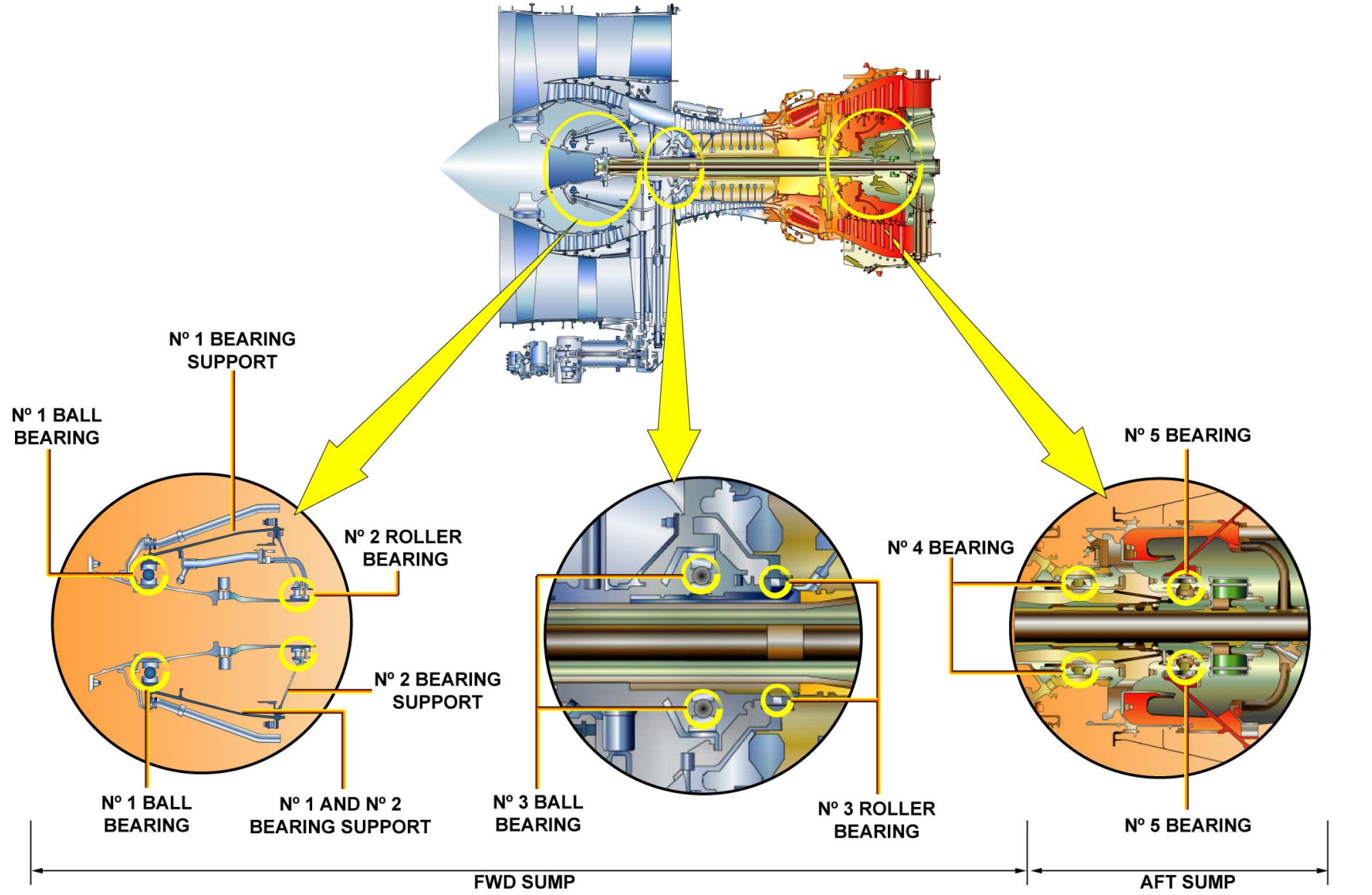

ENGINE BEARINGS - NO.1 AND NO.2 BEARING ... NO.4 AND NO.5 BEARING

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ENGINE SYSTEM D/O (3)

ENGINE SEALS

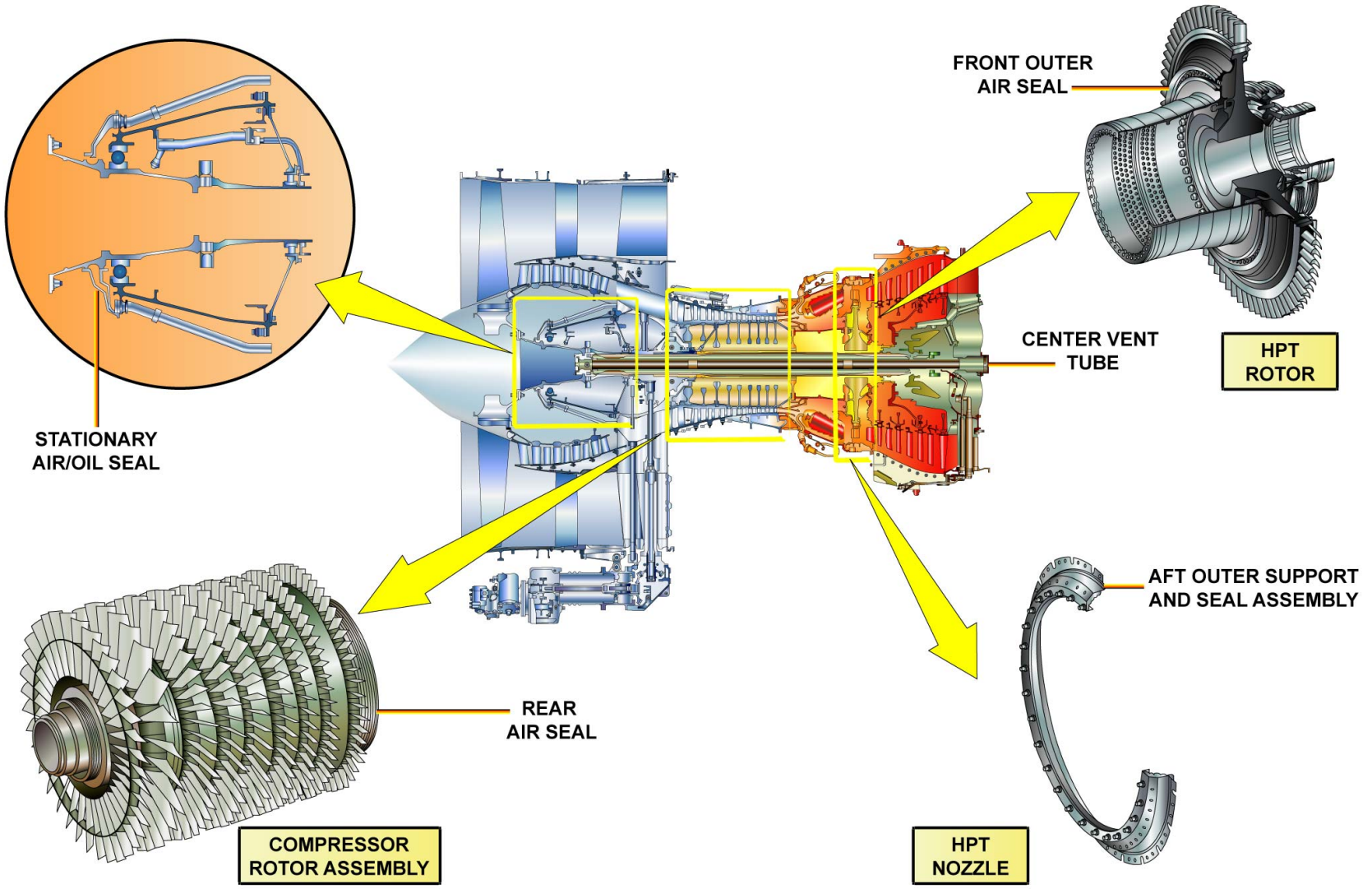
The oil is confined and recirculated in the bearing thanks to the air/oil seal.

FORWARD STATIONARY AIR/OIL SEAL

The stationary air/oil seal limits the engine forward sump at its front end, and is used to duct pressurization air to labyrinths provided on the No. 1 bearing sleeve. The space located between the seal inner and outer skin is divided into independent compartments for pressurization, drainage and oil scavenge.

CENTER-VENT TUBE

Engine sumps are vented to ambient pressure through the center-vent tube contained in the LP shaft.



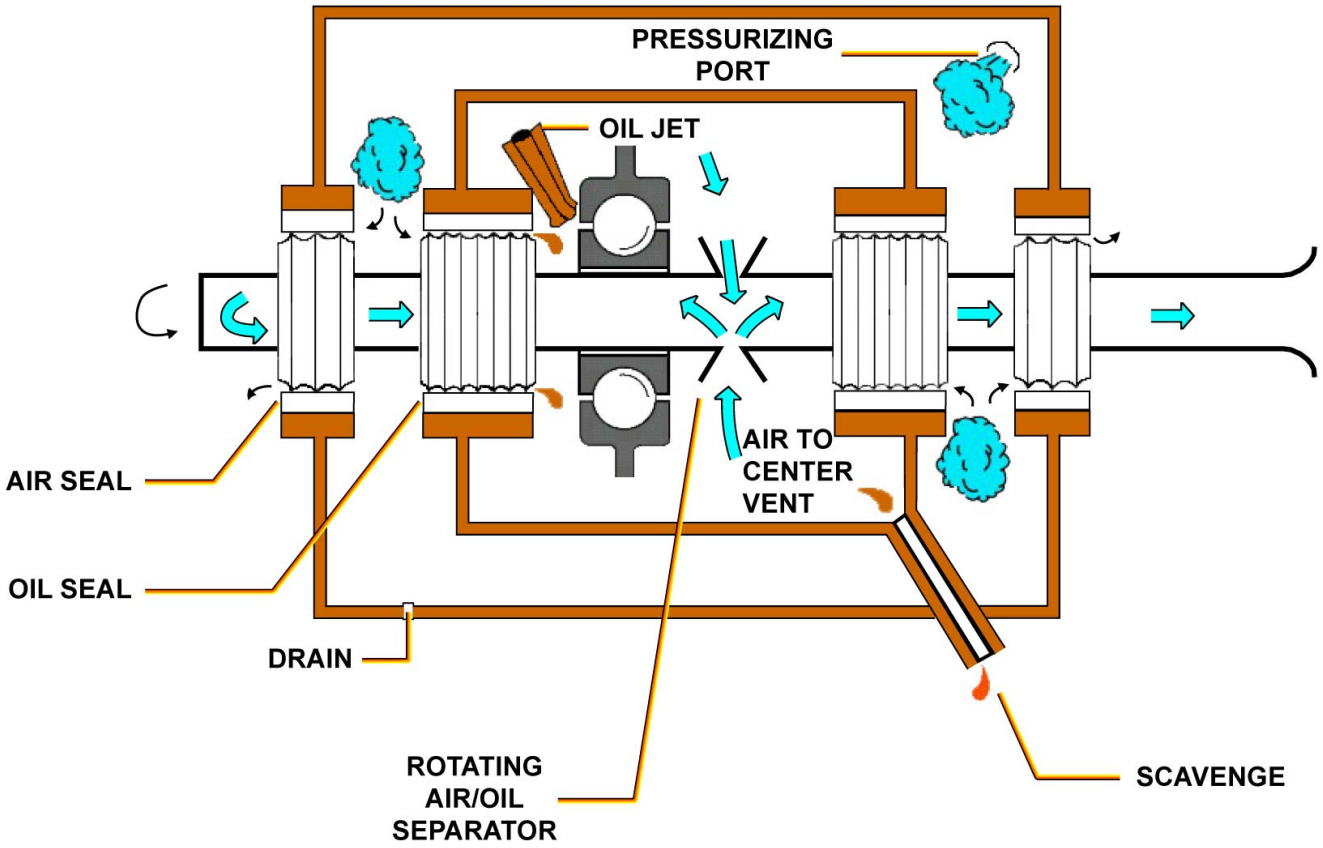
ENGINE SEALS - FORWARD STATIONARY AIR/OIL SEAL & CENTER-VENT TUBE

ENGINE SYSTEM D/O (3)

ENGINE SEALS (continued)

SEAL PRESSURIZATION PRINCIPLE

The sumps are sealed with labyrinth type oil seals, which must be pressurized in order to make sure that the oil is retained within the oil circuit and, therefore, minimize oil consumption.
Pressurization air is extracted from the primary airflow (booster discharge) and injected between the two labyrinth seals. The air, looking for the path with the least resistance, flows across the oil seal, thus preventing oil from escaping.
Any oil that might cross the oil seal is collected in a cavity between the seals and routed to drain pipes.
Once inside the oil sump cavity, the pressurization air becomes vented air and is directed to an air/oil rotating separator and then, out of the engine through the center vent tube, the rear extension duct and the flame arrestor.



SEALS PRESSURIZATION PRINCIPLE

ENGINE SEALS - SEAL PRESSURIZATION PRINCIPLE

ENGINE SYSTEM D/O (3)

COMPRESSOR

The CFM56-5B has two axial compressor sections, one for each shaft: the Low Pressure Compressor (LPC) fan booster section, and the High Pressure Compressor (HPC) section.
The LPC is composed of: fan frame, fan booster rotor, and fan booster stator.
The HPC section is divided into: HPC rotor, and HPC stator.

FAN FRAME ASSEMBLY

The fan frame module carries inlet cowl loads to support the fan, booster and HPC and their bearings, contains the forward mount and supports transfer and accessory gearboxes. It provides ducting for primary and secondary airflows and variable bleed valves.

FAN BOOSTER ROTOR

The fan rotor consists of one full diameter single stage fan for the secondary flow and a four-stage booster for the core engine flow.

FAN BOOSTER STATOR

Fixed stator vanes are installed for both, the fan and booster rotor. The casing is supported by the fan frame and supports the accessory drive gearbox. TECH INSERTION CFM56 technology introduces re-designed HPC rotor blades to improve HPC efficiency.

HPC ROTOR

The HPC compressor rotor is a 9-stage axial flow assembly. The rotor consists of stages 1-2 spool, stage 3 disk, stages 4-9 spool.

HPC STATOR ASSEMBLY

All 9 stages of the compressor stator are shrouded. The Inlet Guide Vanes (IGVs) and the stator vanes of the following 3 stages of the compressor are variable - called Variable Stator Vanes (VSVs).

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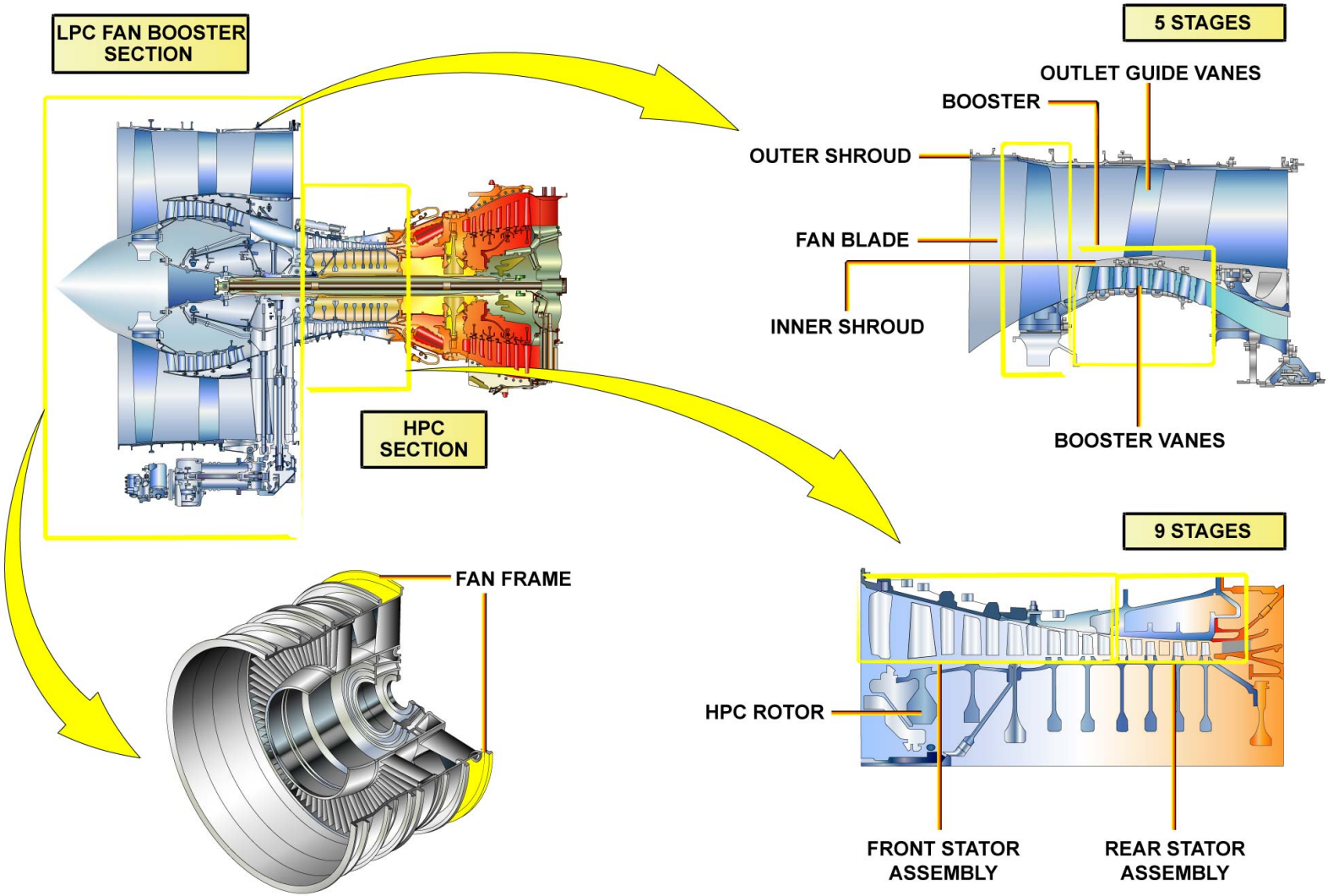

COMPRESSOR - FAN FRAME ASSEMBLY ... HPC STATOR ASSEMBLY

ENGINE SYSTEM D/O (3)

COMPRESSOR OPERATION

The compressor forces the airflow through the engine increasing its pressure. The mechanical energy that the turbine provides to the compressor shaft is transmitted to the airflow with the compressor blades.
In the stator the airflow is compressed progressively. Before entering the combustion chamber the last stator vanes, called Outlet Guide Vanes, must redirect the airflow.
Due to the compression ratio the airflow tries to expand counter direction.
If the compressor is incapable to compress the airflow, the compressor is surging.
Stall is a local effect where the airflow is not compressed. Stall effects can bring the compressor to surge.
To prevent the compressor surge the stall effects are controlled through the methods of airflow control. The Variable Stator Vanes (VSVs) and the variable bleed valves are used to optimize stall margin.

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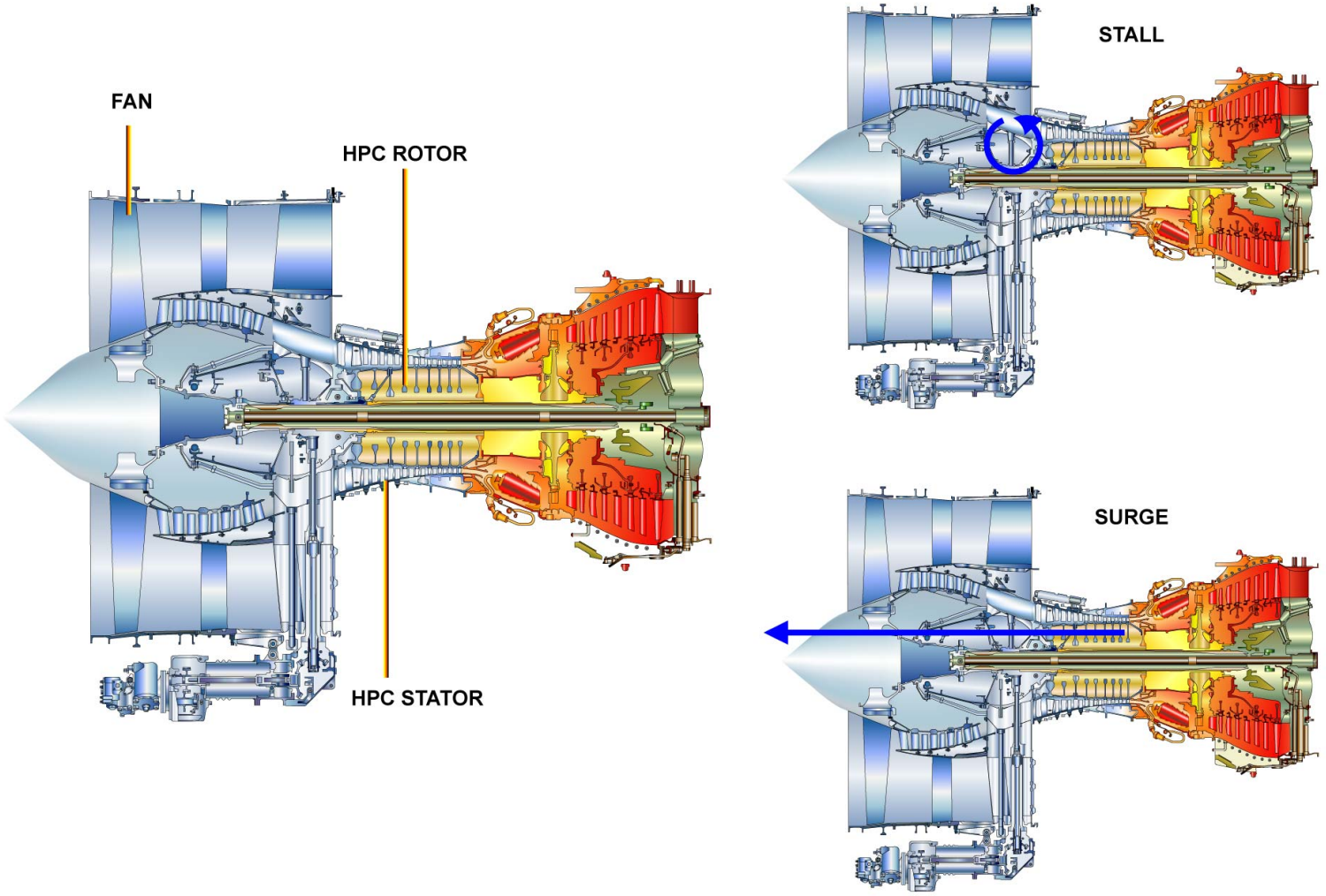

COMPRESSOR OPERATION

ENGINE SYSTEM D/O (3)

COMBUSTION CHAMBER

The basic CFM56-5B engines have a Single Annular Combustor configuration.
The case includes the compressor Outlet Guide Vanes (OGVs) and a diffuser for the reduction of combustion chamber sensitivity to the compressor air velocity profile.
TECH INSERTION CFM56 technology introduces modified dilution and improved cooling profile to reduce NOx emissions and meets Committee on Aviation Environmental Protection (CAEP) 6^{th} meeting for high thrust 5B engines.

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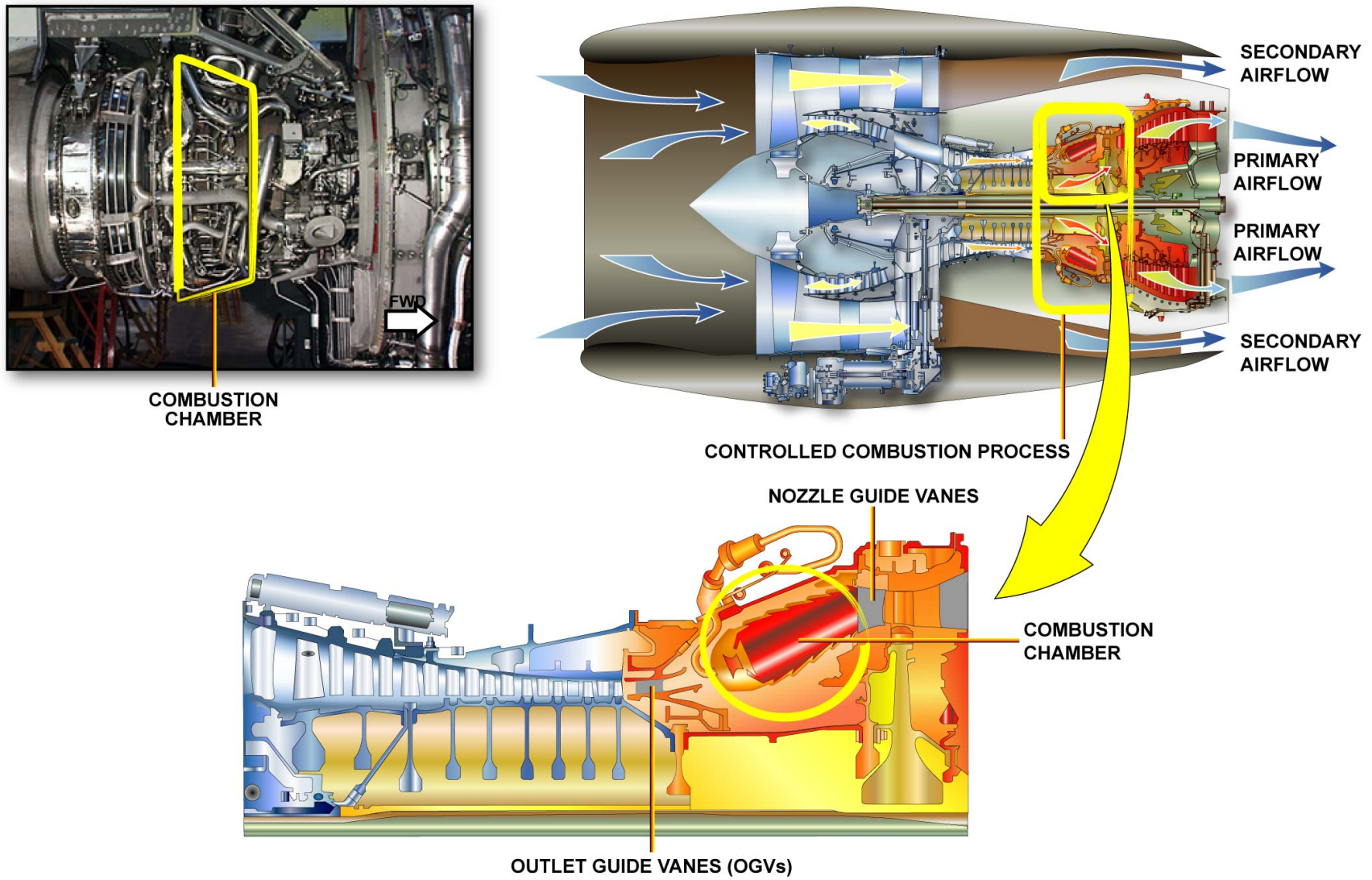
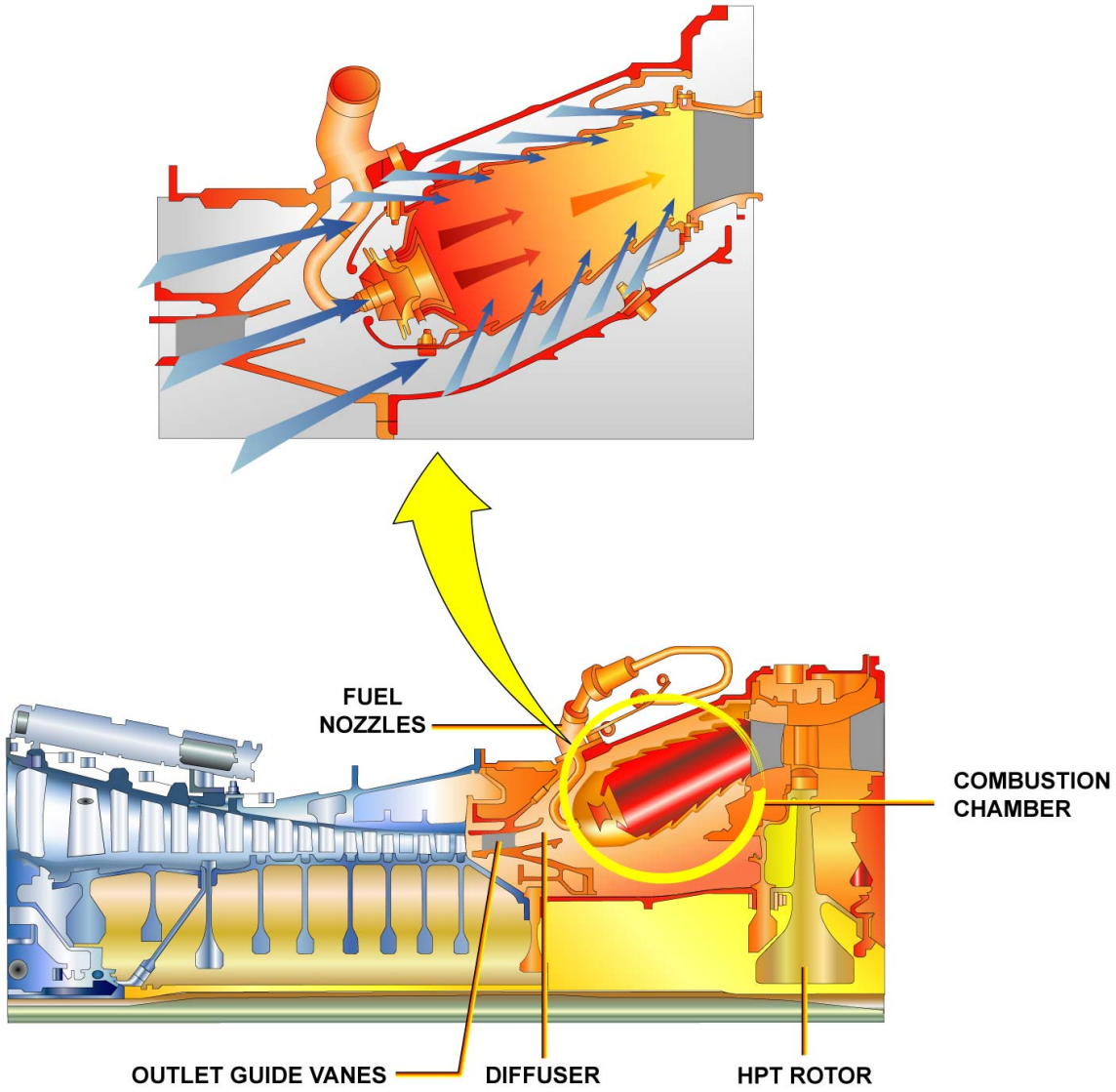


COMBUSTION CHAMBER

ENGINE SYSTEM D/O (3)

COMBUSTION CHAMBER OPERATION

HP gases from the compressor pass through the OGVs that redirect them, then in the diffuser decrease their velocity and enter in the combustion chamber. The gases are mixed with the fuel from the spray nozzles. When the mixture encounters the burning zones, the combustion process starts. The combustion process finishes before entering the HPT nozzles.
The flow is divided into the flow that goes through the combustion chamber and the flow that encircles it.
The flow that enters the combustion chamber goes first through the dome in Single Annular Combustor engine and cools its surface.
The flow that encircles the combustion chamber is mixed with the combusted gases entering the HPT nozzles to reduce the gas temperature at the turbine inlet and provide a film cooling to the first turbine nozzle.



COMBUSTION CHAMBER OPERATION

ENGINE SYSTEM D/O (3)

TURBINE SECTION

The turbine section is formed by two modules: the HPT module and the LPT module. The HPT module consists of 1-stage nozzle and rotor and the LPT consists of 4-stage nozzle and rotor.
The turbines provide energy to increase the pressure of the airflow in the compressors and to power all the accessories that the aircraft needs.

HPT NOZZLE ASSEMBLY

The HPT nozzle is a single-stage air-cooled assembly that mounts in the combustion case and directs the gas flow from the combustion chamber into the blades of the HPT rotor.

HPT ROTOR ASSEMBLY

The HPT rotor is a single-stage, air-cooled, high-efficiency turbine. TECH INSERTION CFM56 technology introduces new HPT blades with lower aerodynamic loss in between HPT and LPT, resulting in reduced fuel burn.

HPT SHROUD AND LPT 1 STAGE NOZZLE ASSEMBLY

The HPT shroud and stage 1 LPT nozzle assembly is located inside the combustion case.

LPT STATOR ASSEMBLY

The LPT assembly consists of the LPT case assembly, stages 2-4 LPT nozzle assemblies and the air-cooling tubes and manifolds assembly.

LPT ROTOR ASSEMBLY

The LPT rotor assembly is composed of: LPT disks, stage 1 blade assembly, rotating air seals, stages 2-4 of LPT rotor and, turbine rotor support.

TURBINE FRAME ASSEMBLY

The turbine frame is bolted to the LPT case and supports the primary exhaust nozzle.

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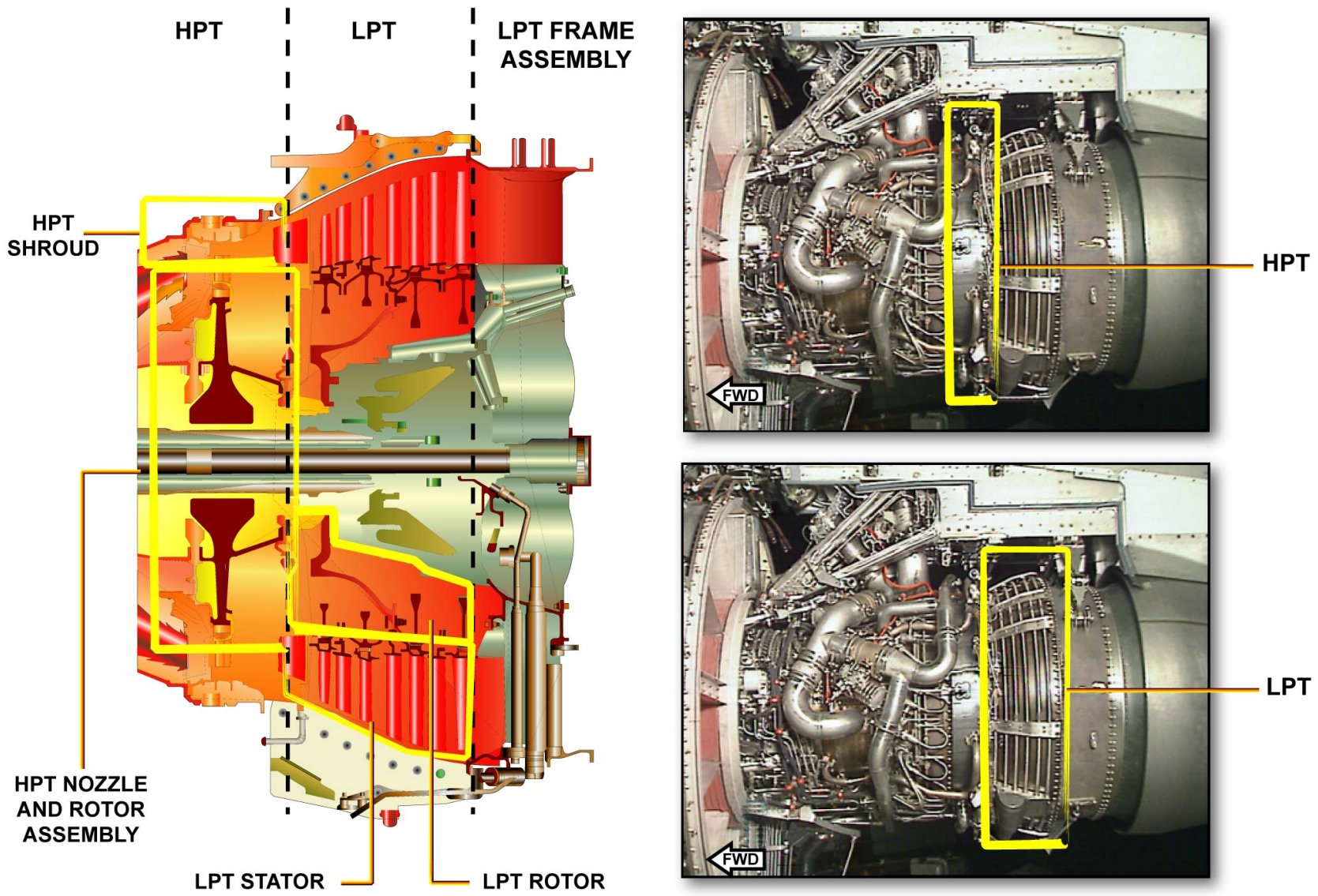

TURBINE SECTION - HPT NOZZLE ASSEMBLY ... TURBINE FRAME ASSEMBLY

ENGINE SYSTEM D/O (3)

TURBINE SECTION (continued)

ACCESSORY GEARBOX

All gears are plug-in units with line replaceable magnetic or spring-loaded carbon seals. The Integrated Drive Generator (IDG), the Engine Driven Pump (EDP) and the Starter are installed to the Accessory Gearbox, using Quick Attach-Detach (QAD) connections.

NOTE: A hand cranking drive for the N2 shaft is provided on the front face.

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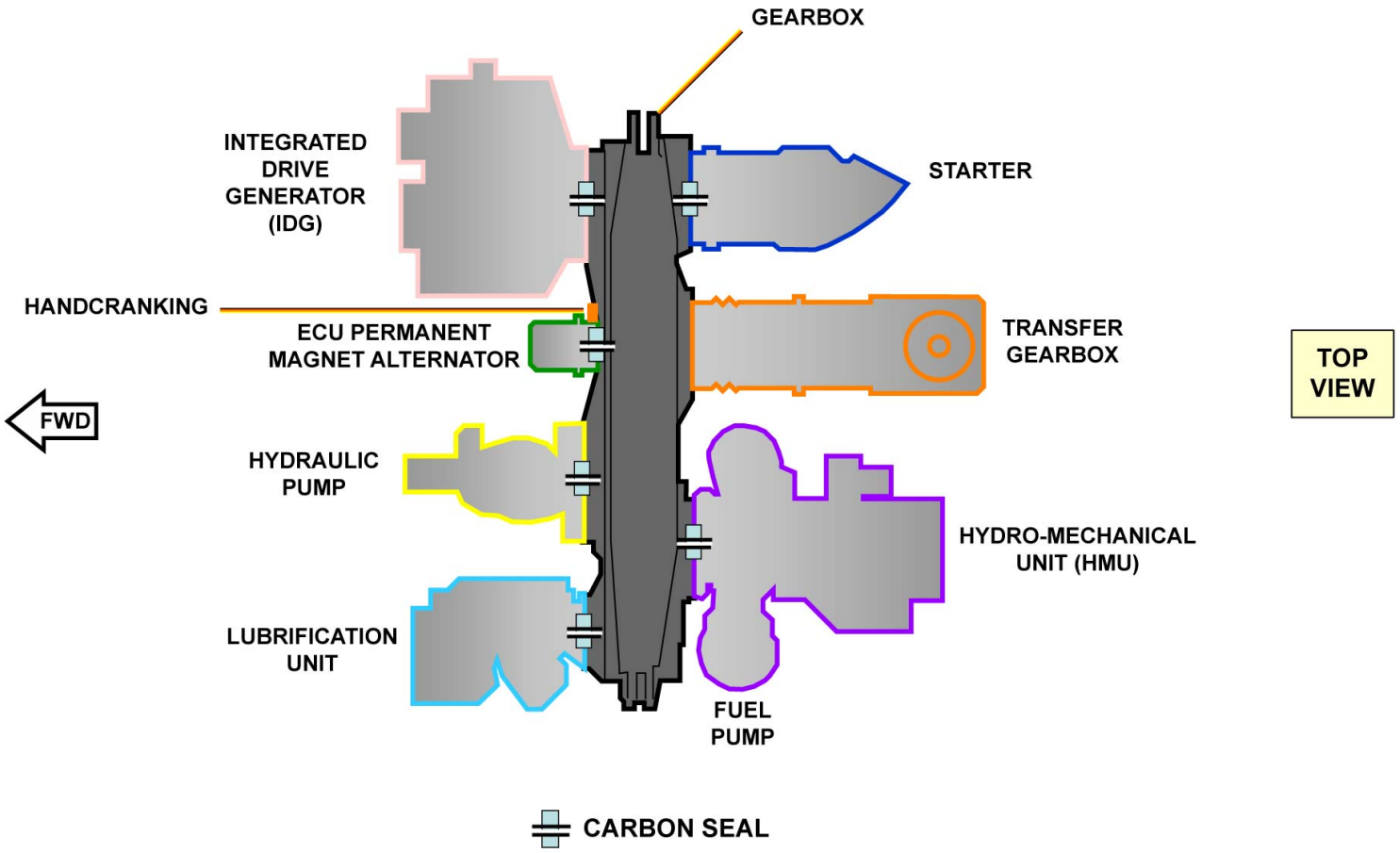

TURBINE SECTION - ACCESSORY GEARBOX

ENGINE SYSTEM D/O (3)

AERODYNAMIC STATIONS

Here are the main aerodynamic stations:
- STA 0: nose cowl inlet,
- STA 2: fan inlet front frame hub section,
- STA 12: fan inlet front frame tip section,
- STA 13: fan OGV discharge,
- STA 25: HPC inlet,
- STA 3: HPC discharge,
- STA 49.5: Exhaust Gas Temperature (EGT) measuring plane,
- STA 5: LPT discharge.

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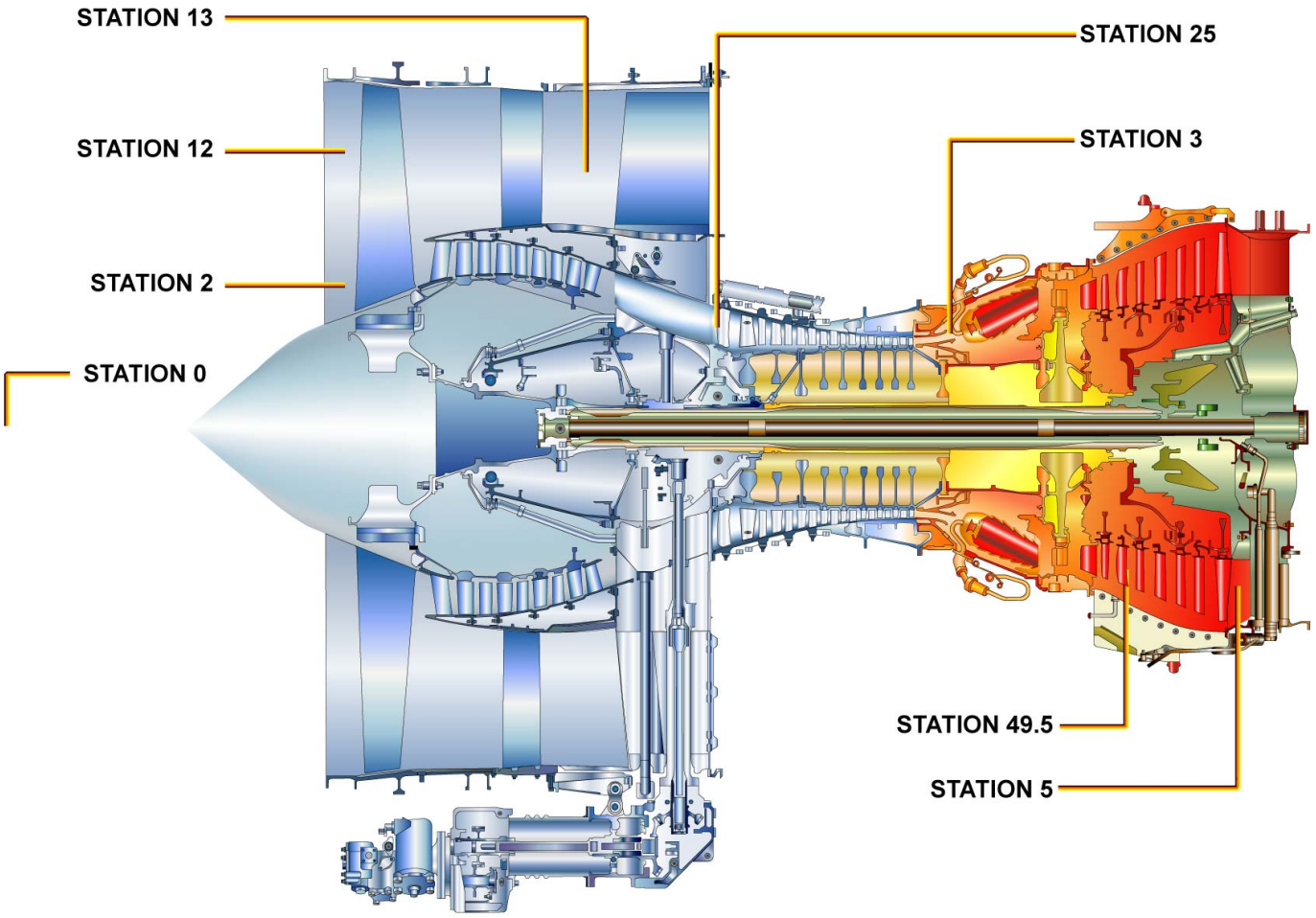

AERODYNAMIC STATIONS

ENGINE SYSTEM D/O (3)

BOROSCOPE PORTS

Several ports are provided on the engine for boroscope inspection. Boroscopes are inspection devices with a rigid or flexible optical tube for insertion into bores and cavities for visualization. Generally, boroscope inspections are realized with an optical tube equipped with a camera. Boroscope port angles are measured clockwise from the top vertical centerline of the engine, aft looking forward.
The HPT blade leading edges can be inspected through the igniter holes.

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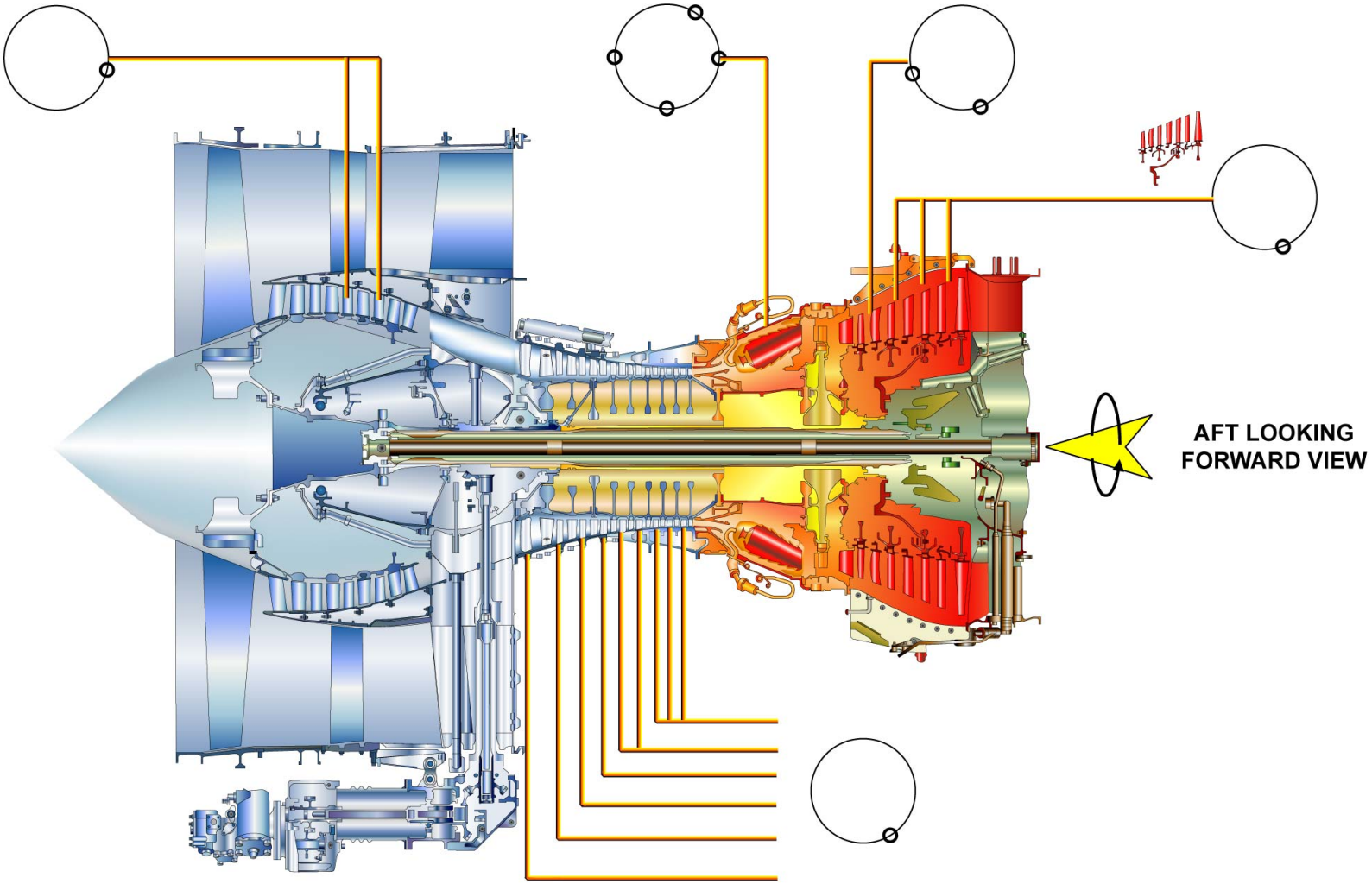
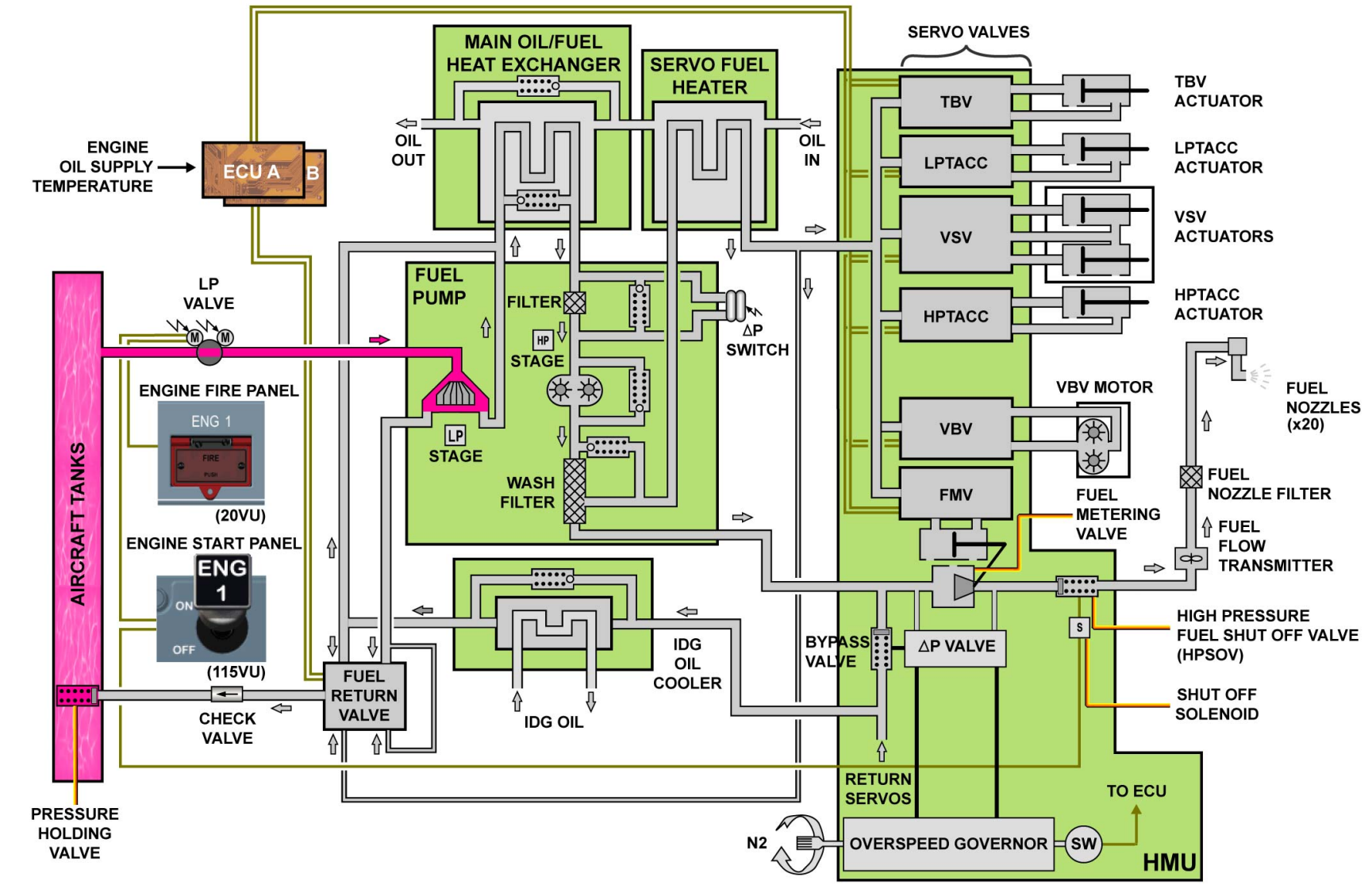


BOROSCOPE PORTS

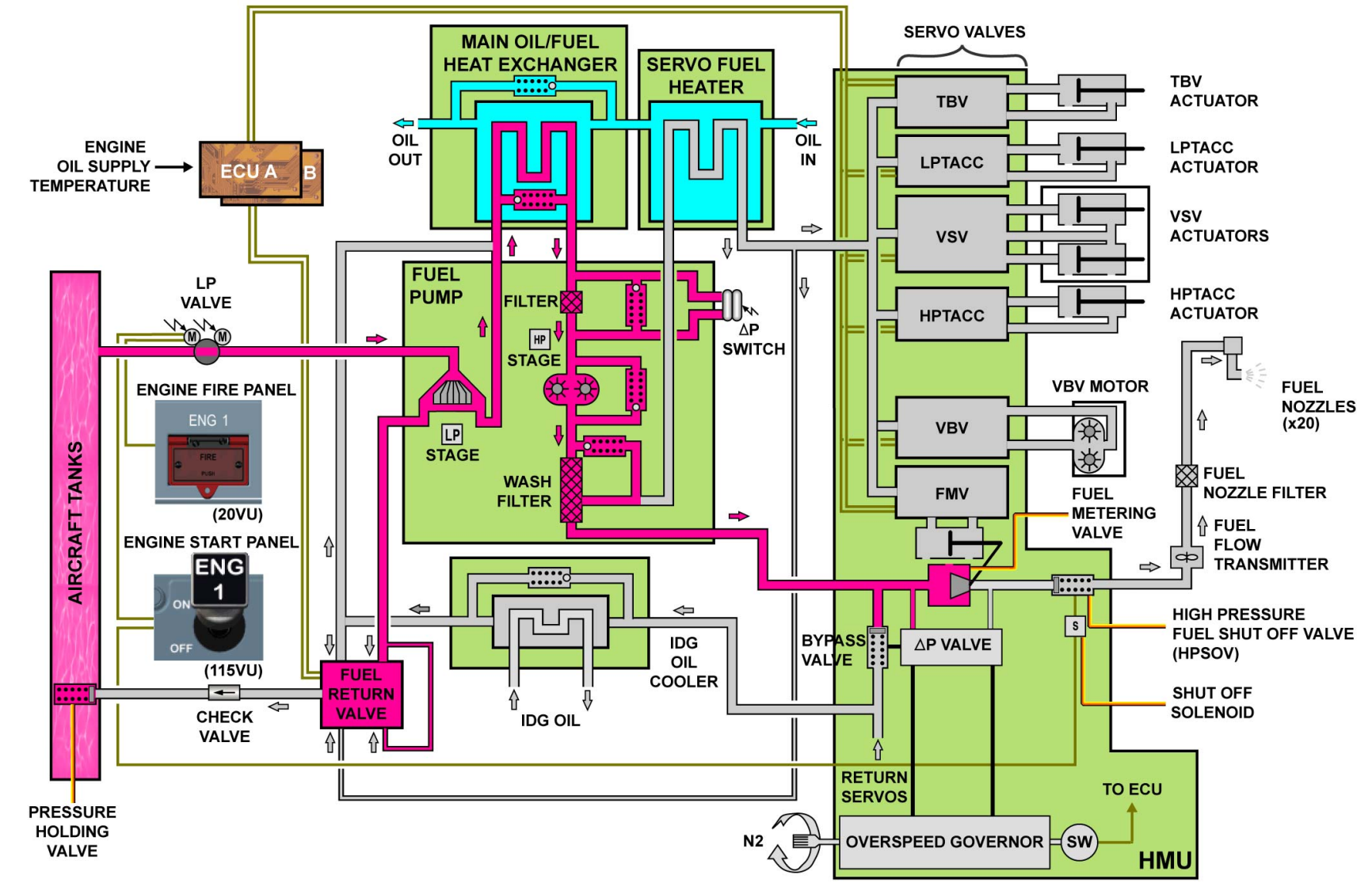
ENGINE FUEL SYSTEM D/O (3)

FUEL FEED

The engine fuel system is designed to supply Fuel Flow (FF) into the combustion chamber, servo fuel for compressor airflow control and engine clearance control system actuation and cooling for engine oil and Integrated Drive Generator (IDG) oil.
The fuel coming from the A/C tanks through the LP valve is driven by the LP stage of the fuel pump.
It is heated by the main oil/fuel heat exchanger, filtered, and then pressurized in the High Pressure (HP) stage of the fuel pump before entering the Hydromechanical Unit (HMU).


MAIN OIL/FUEL HEAT EXCHANGER
SERVO FUEL HEATER
SERVO VALVES
TBV
LPTACC
VSV
HPTACC
VBV
FMV
TBV ACTUATOR
LPTACC ACTUATOR
VSV ACTUATORS
HPTACC ACTUATOR
VBV MOTOR
FUEL NOZZLES (x20)
FUEL NOZZLE FILTER
FUEL METERING VALVE
FUEL FLOW TRANSMITTER
HIGH PRESSURE FUEL SHUT OFF VALVE (HPSOV)
SHUT OFF SOLENOID
OIL OUT
OIL IN
ENGINE OIL SUPPLY TEMPERATURE
ECU A B
FUEL PUMP
FILTER
HP STAGE
LP STAGE
WASH FILTER
ΔP SWITCH
LP VALVE
ENGINE FIRE PANEL
ENG 1
FIRE
PUSH
(20VU)
ENGINE START PANEL
ENG 1
ON
OFF
(115VU)
AIRCRAFT TANKS
CHECK VALVE
FUEL RETURN VALVE
IDG OIL
IDG OIL COOLER
BYPASS VALVE
ΔP VALVE
S
RETURN SERVOS
TO ECU
N2
OVERSPEED GOVERNOR
SW
HMU
PRESSURE HOLDING VALVE

FUEL FEED


MAIN OIL/FUEL HEAT EXCHANGER
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SW
HMU
PRESSURE HOLDING VALVE

FUEL FEED

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UG913131 - U7RT0EC - UM73D1CFM000001

ENGINE FUEL SYSTEM D/O (3)

METERED FUEL

The fuel from the fuel pump goes through a Fuel Metering Valve (FMV) and a High Pressure Fuel Shut-Off Valve included in the HMU.
The fuel flows through the fuel flow transmitter, then through a fuel nozzle filter, then to the nozzles.

OVERSPEED PROTECTION

The overspeed governor system limits the core engine speed (N2) to a maximum of 106%, in the event of a malfunction that could drive the engine into an overspeed condition.
The overspeed governor is hydro-mechanical (flyweights) and independent of the ECU.
The Delta P valve is hydraulically forced to cause the by-passed valve to stroke more open.
More fuel is by-passed, decreasing fuel flow to the FMV and, therefore, less fuel is available for combustion.
TEST by ECU
At each engine start, the micro-switch informs the ECU that the governor system is in operation. This micro-switch strokes open/close around 45% of N2.

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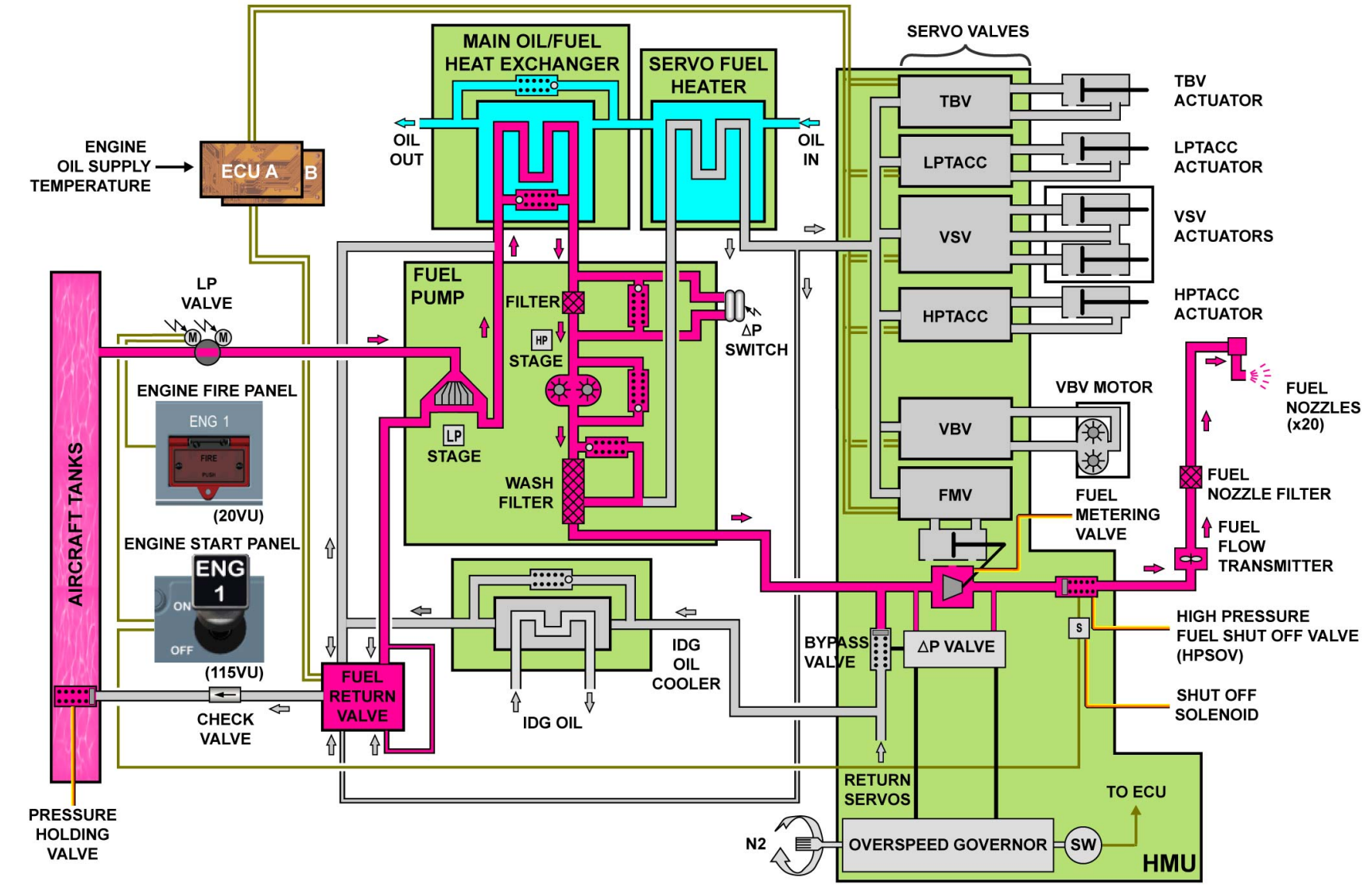

METERED FUEL & OVERSPEED PROTECTION

ENGINE FUEL SYSTEM D/O (3)

HP FUEL SHUT-OFF VALVE CONTROL

The High Pressure (HP) fuel Shut-Off Valve (SOV) can be controlled from the cockpit through the engine start panel or by the Electronic Control Unit (ECU) through the Fuel Metering Valve (FMV), during engine start.

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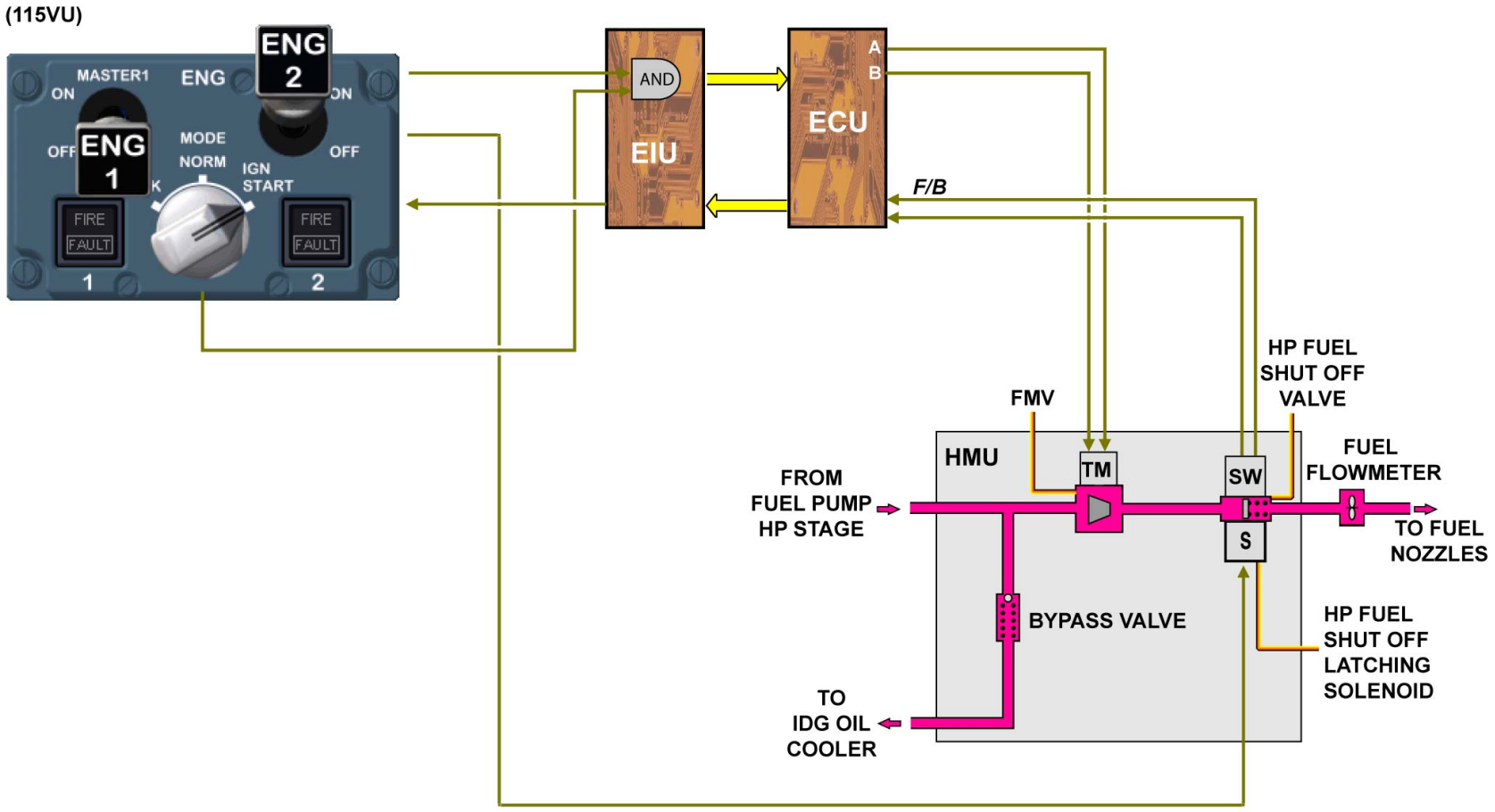


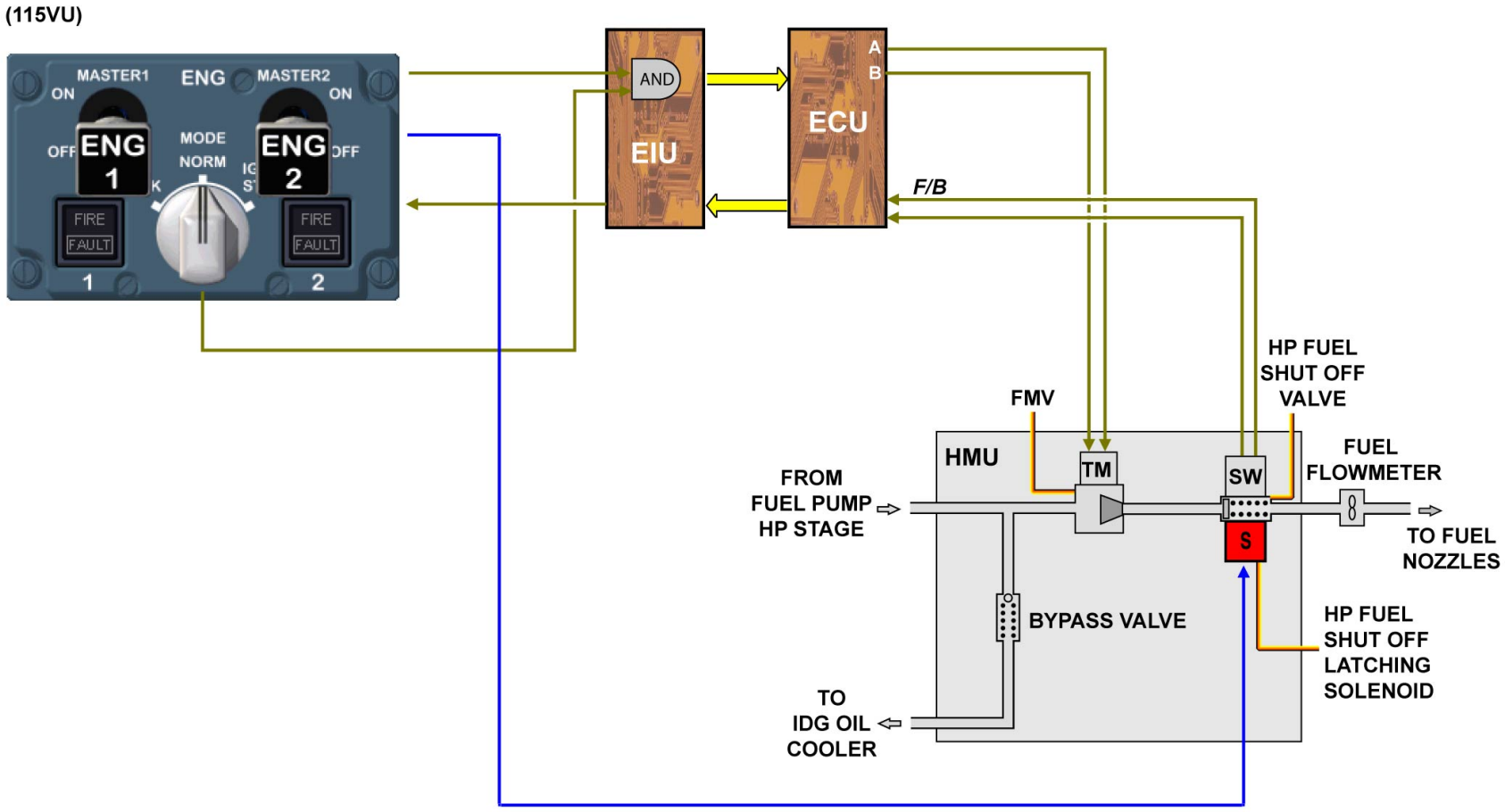
HP FUEL SHUT-OFF VALVE CONTROL

ENGINE FUEL SYSTEM D/O (3)

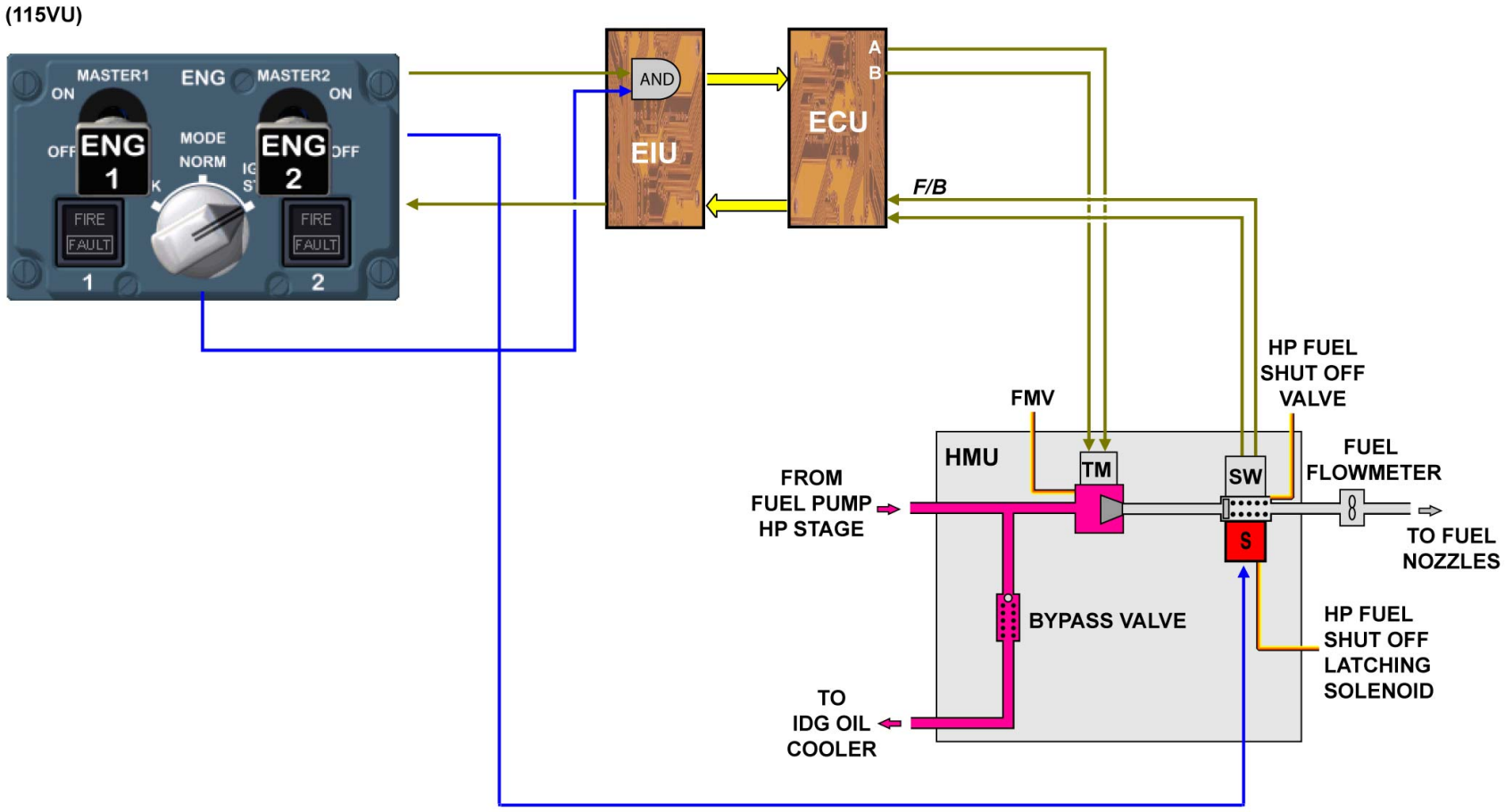
HP FUEL SHUT-OFF VALVE CONTROL (continued)

HPSOV OPENING

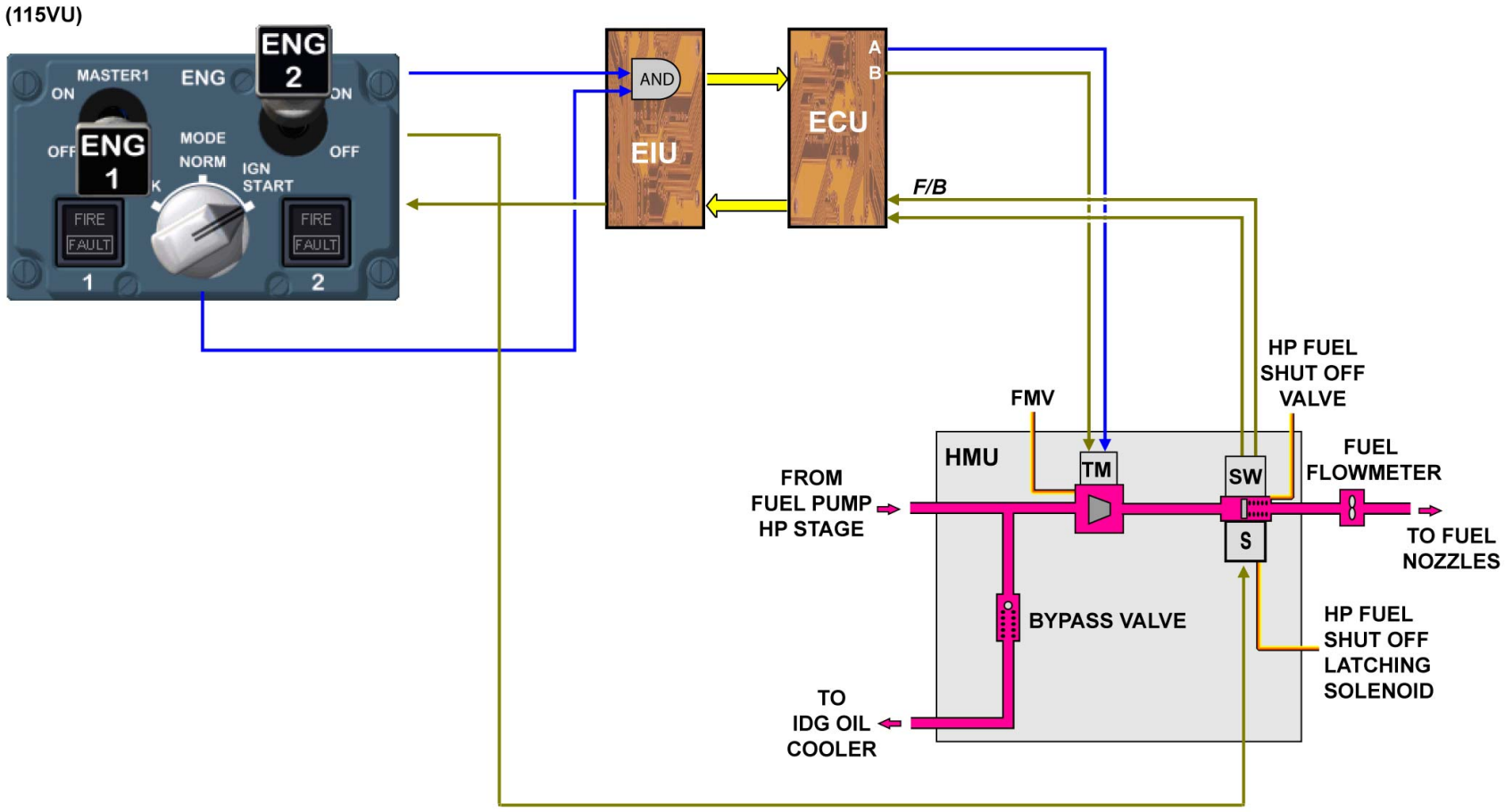
When the MASTER lever is set to OFF, the HPSOV shut-off solenoid is energized.
During the start sequence, the rotary selector is set to IGNition START and the 28V DC power supplies the EIU.
When the MASTER lever is set to ON, the HPSOV shut-off solenoid is de-energized and an additionally control signal is sent to EIU.
The ECU channel A controls the FMV opening-closing via the Torque Motor.
When the FMV is opened, by the ECU, it provides a command pressure to open the HP fuel SOV.
Opening of the HP fuel SOV is also possible when the rotary selector is set to CRANK and the MASTER lever is set to ON, to permit a wet motoring.



HP FUEL SHUT-OFF VALVE CONTROL - HPSOV OPENING



HP FUEL SHUT-OFF VALVE CONTROL - HPSOV OPENING



HP FUEL SHUT-OFF VALVE CONTROL - HPSOV OPENING

ENGINE FUEL SYSTEM D/O (3)

HP FUEL SHUT-OFF VALVE CONTROL (continued)

HPSOV CLOSING

The closure of the HP fuel SOV is controlled directly from the MASTER lever when it is set to the OFF position.
When it is set to the OFF position, it energizes the HP fuel Shut-Off latching solenoid. The MASTER lever command has priority over the ECU command.
During the start sequence, if a start abort is initiated, the ECU will close the FMV, which will result in closure of the HP fuel SOV.

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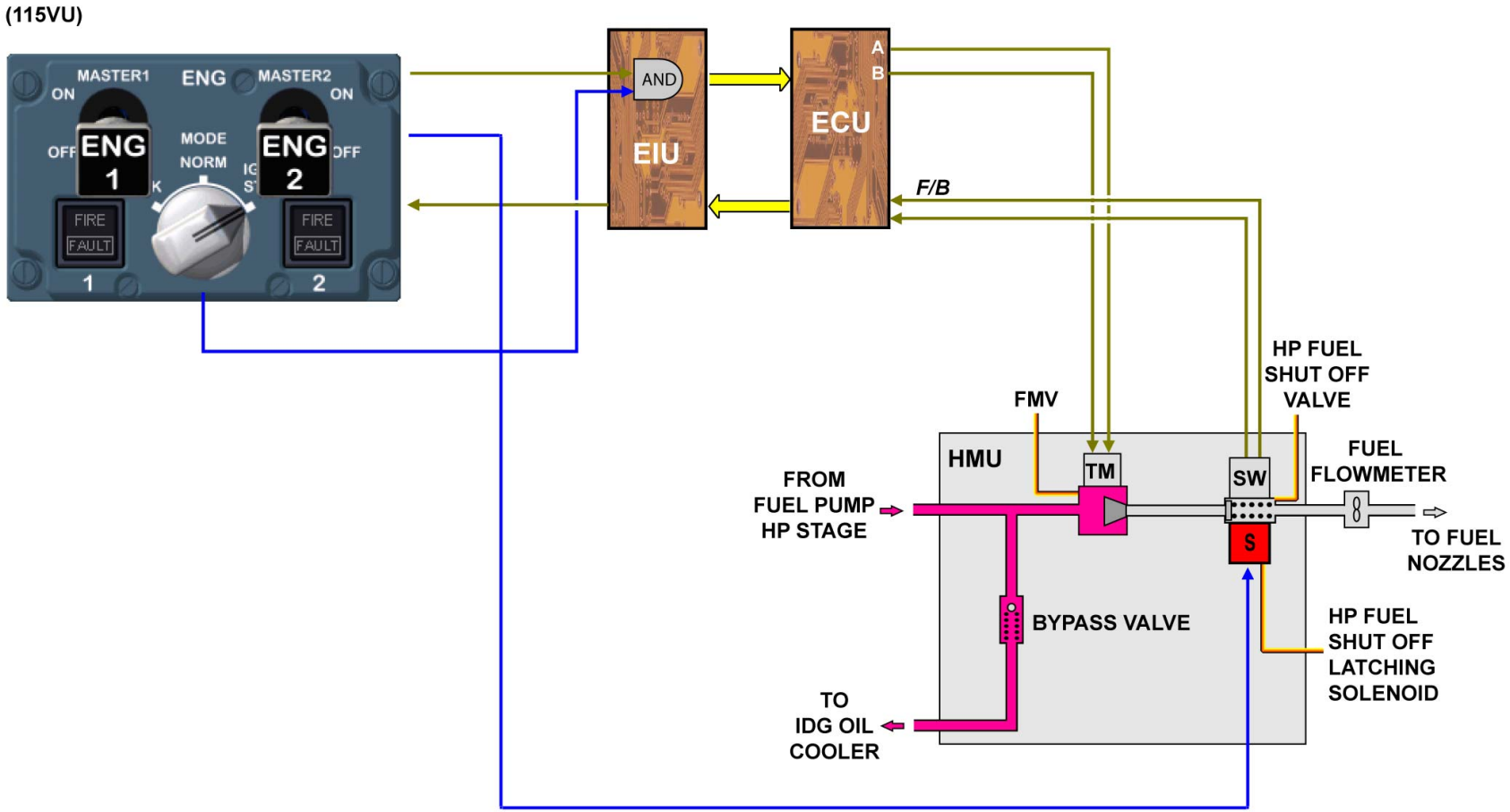

HP FUEL SHUT-OFF VALVE CONTROL - HPSOV CLOSING

ENGINE FUEL SYSTEM D/O (3)

HP FUEL SHUT-OFF VALVE CONTROL (continued)

MONITORING

The HP fuel SOV is monitored by two microswitches which send signals to the ECU and then to the Engine Interface Unit (EIU). In case of disagreement between control and position, an ECAM warning is triggered and the engine FAULT light comes on.

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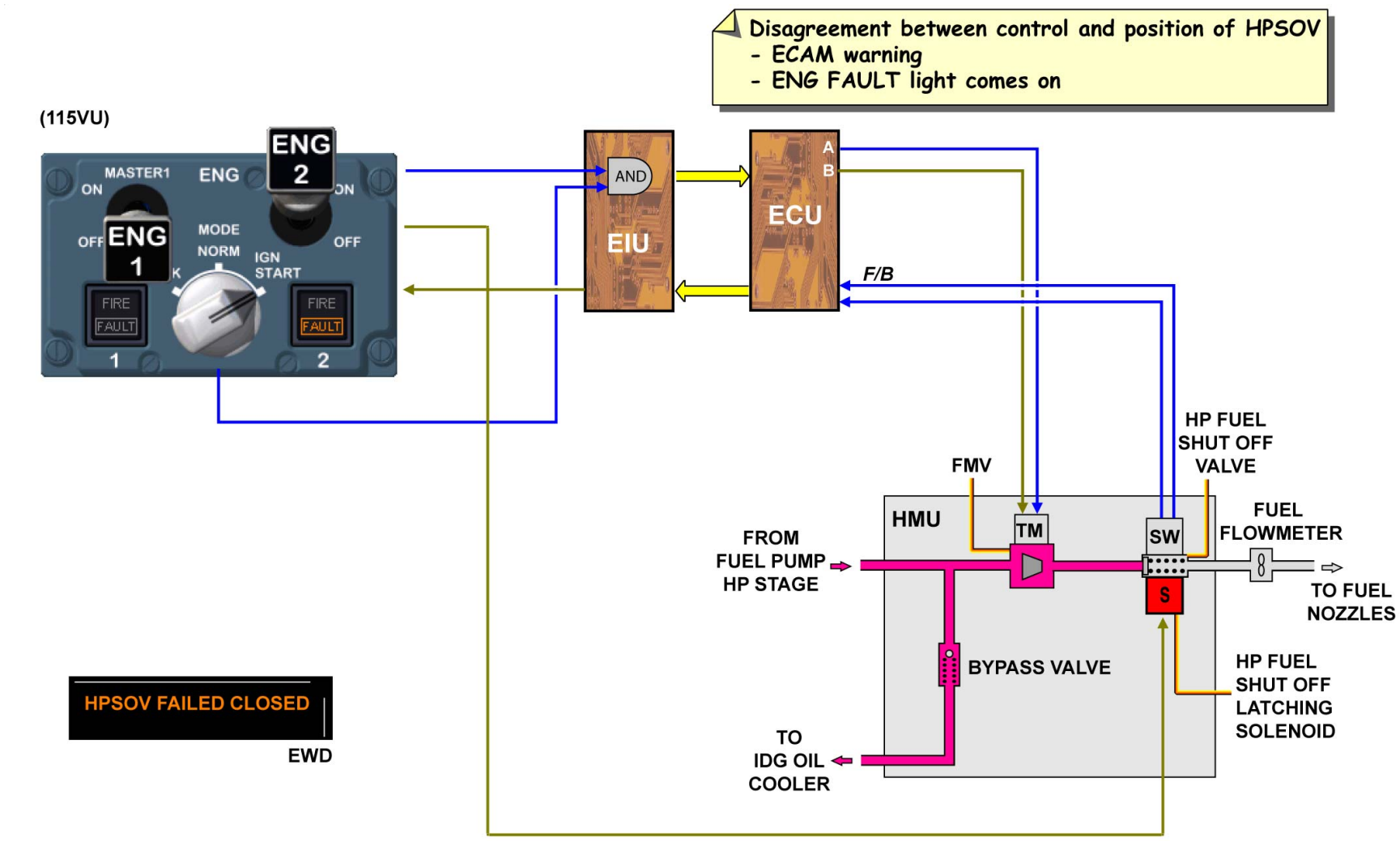
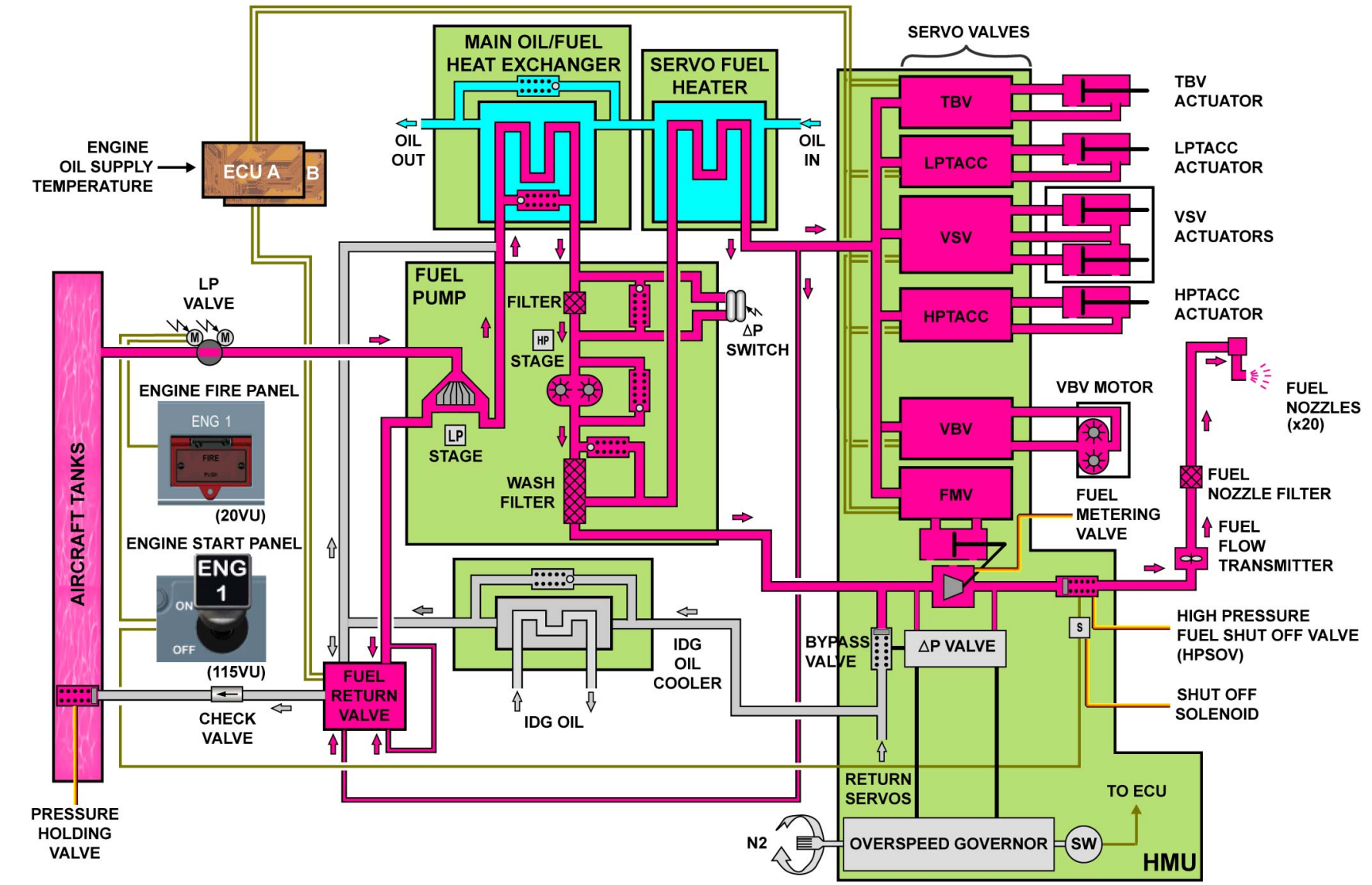


HP FUEL SHUT-OFF VALVE CONTROL - MONITORING

ENGINE FUEL SYSTEM D/O (3)

SERVO FUEL

The FMV is controlled by the Electronic Control Unit (ECU) to obtain the desired N1, selected either by the thrust lever or the Auto Thrust System. Filtered fuel is delivered, from a self-cleaning wash filter, through a servo fuel heater to the servo valves of the HMU.
Part of this fuel is also delivered to the FRV as muscle pressure.
In the HMU, the servo valves are hydraulically driven by torque motors controlled by the ECU to provide the operation of:
- Transient Bleed Valve (TBV),
- Low Pressure Turbine Active Clearance Control (LPTACC),
- Variable Stator Vanes (VSV),
- High Pressure Turbine Active Clearance Control (HPTACC),
- Variable Bleed Valves (VBV),
- FMV.


MAIN OIL/FUEL HEAT EXCHANGER
SERVO FUEL HEATER
SERVO VALVES
TBV
LPTACC
VSV
HPTACC
VBV
FMV
TBV ACTUATOR
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VSV ACTUATORS
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FUEL NOZZLES (x20)
FUEL NOZZLE FILTER
FUEL METERING VALVE
FUEL FLOW TRANSMITTER
HIGH PRESSURE FUEL SHUT OFF VALVE (HPSOV)
SHUT OFF SOLENOID
ENGINE OIL SUPPLY TEMPERATURE
ECU A B
OIL OUT
OIL IN
FUEL PUMP
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HP STAGE
LP STAGE
WASH FILTER
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LP VALVE
ENGINE FIRE PANEL
ENG 1
FIRE
PUSH
(20VU)
ENGINE START PANEL
ENG 1
ON
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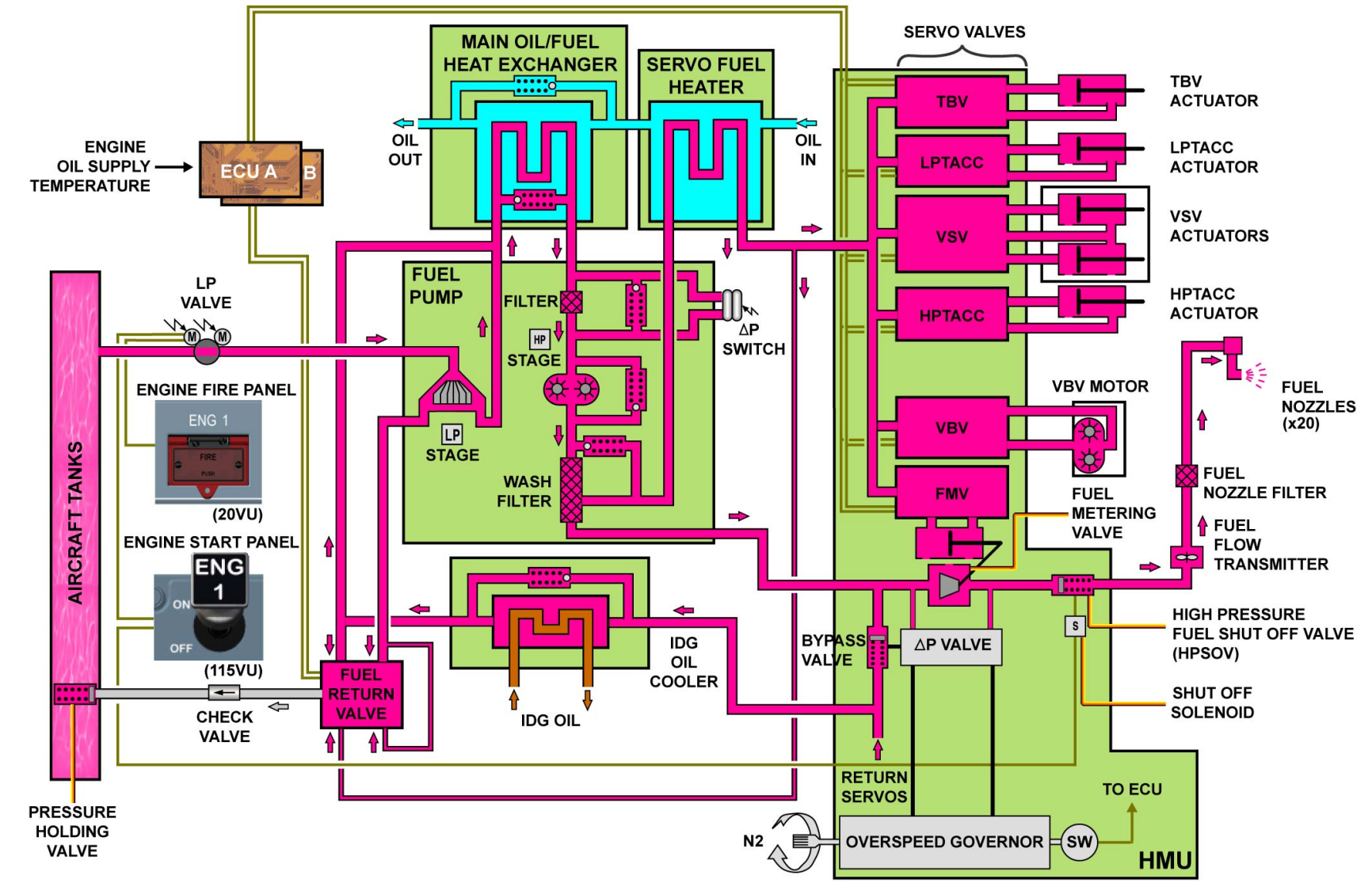
AIRCRAFT TANKS
CHECK VALVE
FUEL RETURN VALVE
IDG OIL
IDG OIL COOLER
BYPASS VALVE
ΔP VALVE
S
RETURN SERVOS
TO ECU
N2
OVERSPEED GOVERNOR
SW
HMU
PRESSURE HOLDING VALVE

SERVO FUEL

ENGINE FUEL SYSTEM D/O (3)

IDG OIL COOLING

The fuel bypassed from the HMU and returned from servos is used to cool the IDG oil through the IDG oil cooler.
The fuel then returns to the fuel pump inter-stage and re-circulates through the system.

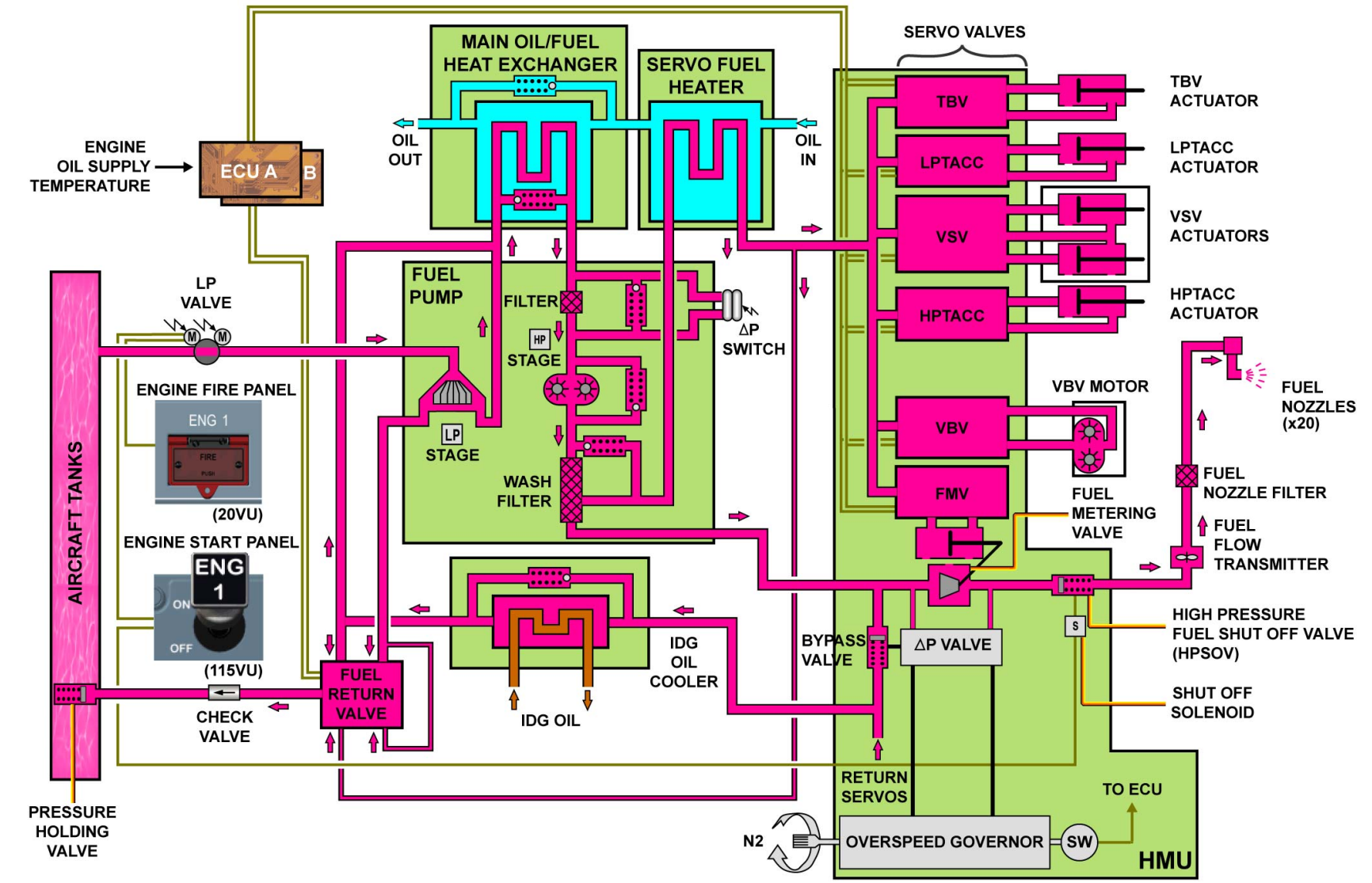


IDG OIL COOLING

ENGINE FUEL SYSTEM D/O (3)

FUEL RETURN VALVE

The FRV is electrically controlled by the ECU, and hydraulically operated by the servo fuel. If the engine oil gets too hot, the ECU controls the FRV to allow some hot fuel to return to the A/C tanks.
The ECU uses the Engine Oil Temperature as its reference because the engine oil gets hot as the IDG oil gets hot, due to the recirculation fuel is going successively through the engine and IDG oil/fuel heat exchangers
The FRV mixes cold fuel from the LP pump with hot return fuel to reduce thermal stresses. The pressure holding valve ensures that there is pressure in the return line, to prevent fuel from boiling when the FRV is open and allowing fuel to return to the tank.



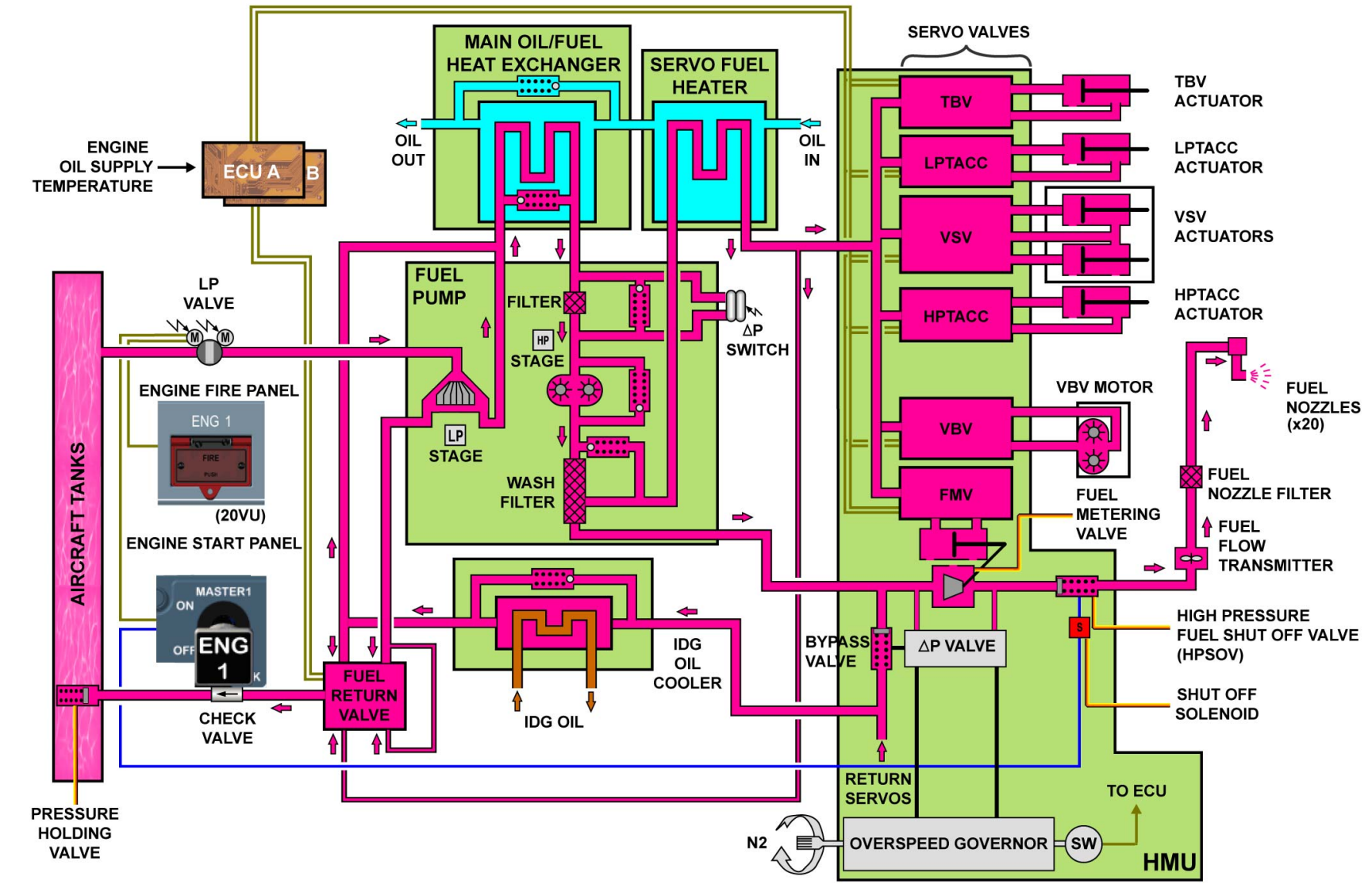
FUEL RETURN VALVE

ENGINE FUEL SYSTEM D/O (3)

NORMAL SHUTDOWN

When the Engine Master Switch is set to 'OFF', the LP and HP fuel shut-off valves are closed as well as the Fuel Return Valve (FRV). The FRV is driven closed by the ECU.

UG913131 - U7RT0EC - UM73D1CFM000001



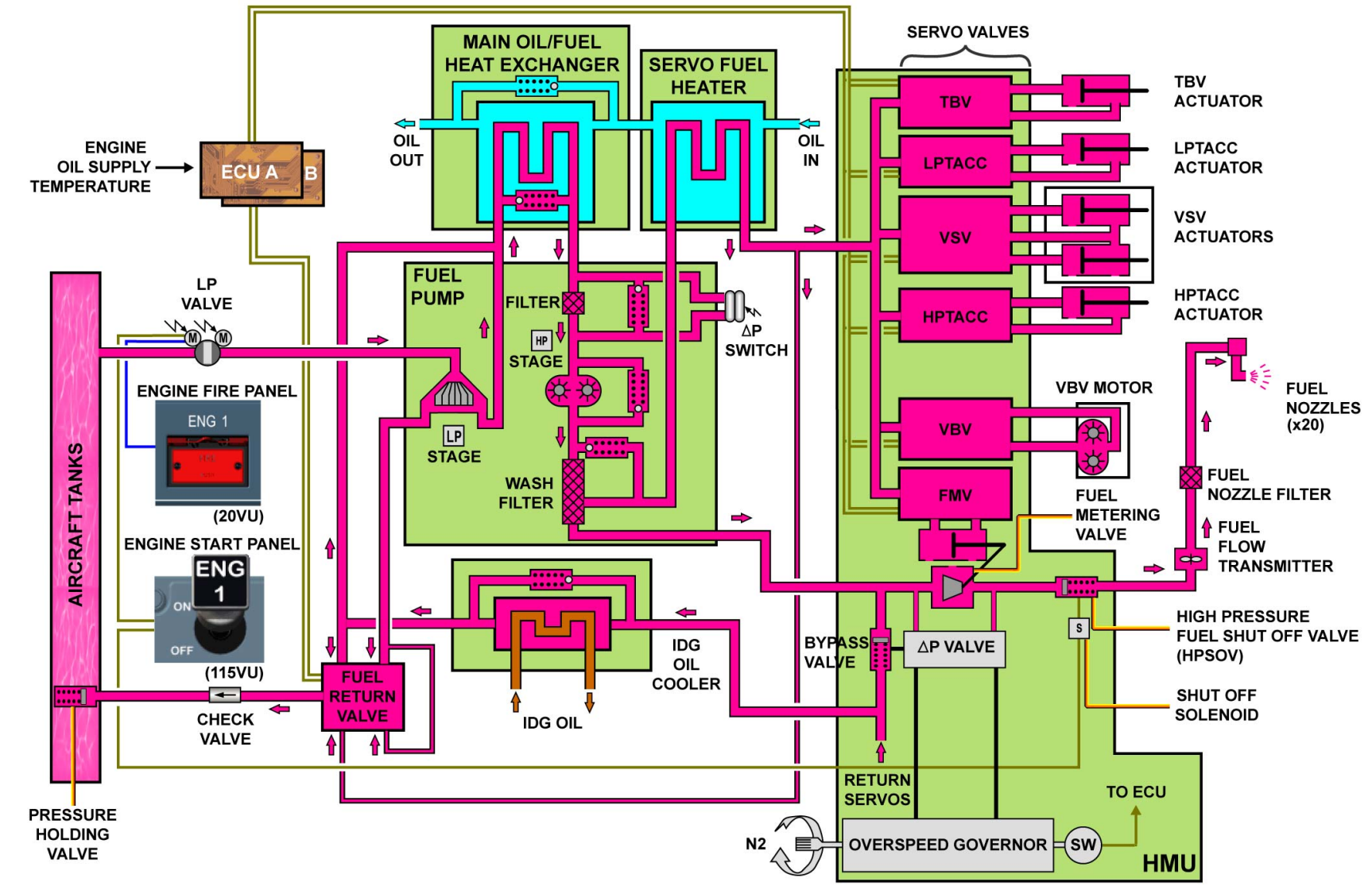
NORMAL SHUTDOWN

ENGINE FUEL SYSTEM D/O (3)

EMERGENCY SHUTDOWN: ENGINE FIRE

In case of emergency, the fire pushbutton is pressed to confirm the closure of the LP shut-off valve following the shutdown of the engine.

UG913131 - U7RT0EC - UM73D1CFM000001



EMERGENCY SHUTDOWN: ENGINE FIRE

ENGINE FUEL SYSTEM D/O (3)

LP FUEL SHUT-OFF VALVE CONTROL

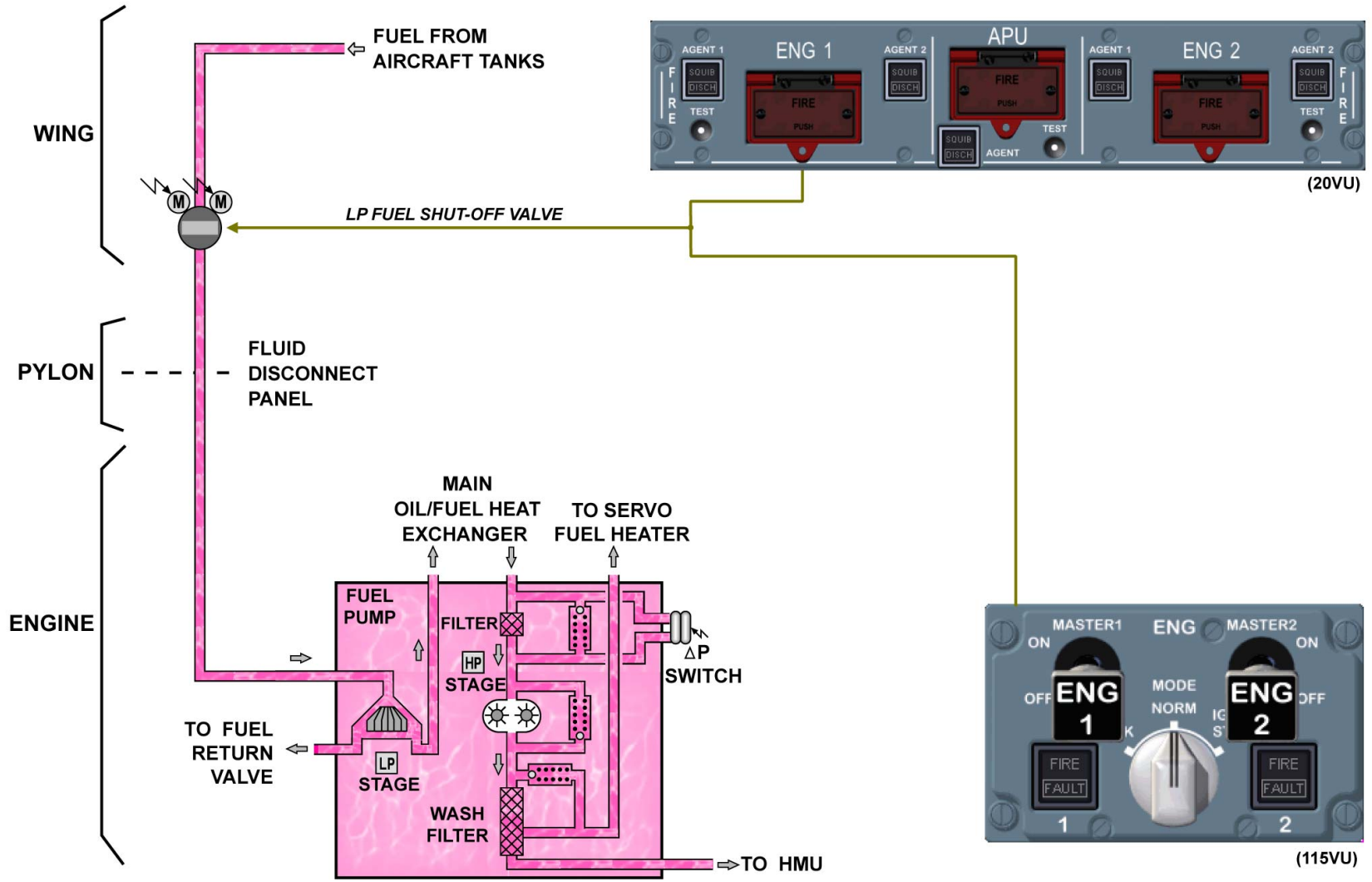
The Low Pressure (LP) fuel Shut-Off Valve (SOV) operation is controlled from the engine fire panel or from the engine start panel.

ENGINE MASTER CONTROL SWITCH

When the ENGine MASTER control switch is set to OFF, both electrical motors drive the LP SOV to the closed position.

ENGINE FIRE PUSHBUTTON COMMAND

When the ENGine FIRE P/B is released out, both electrical motors drive the LP SOV to the closed position.



LP FUEL SHUT-OFF VALVE CONTROL - ENGINE MASTER CONTROL SWITCH & ENGINE FIRE PUSHBUTTON COMMAND

FADEC PRESENTATION (2)

GENERAL

The Full Authority Digital Engine Control (FADEC) system controls the engine. FADEC also interfaces with aircraft signals.
The FADEC system of each engine consists of a dual channel Electronic Control Unit (ECU), with its associated peripherals.
The ECU is the computer of the FADEC system and is located on the engine fan case right hand side.

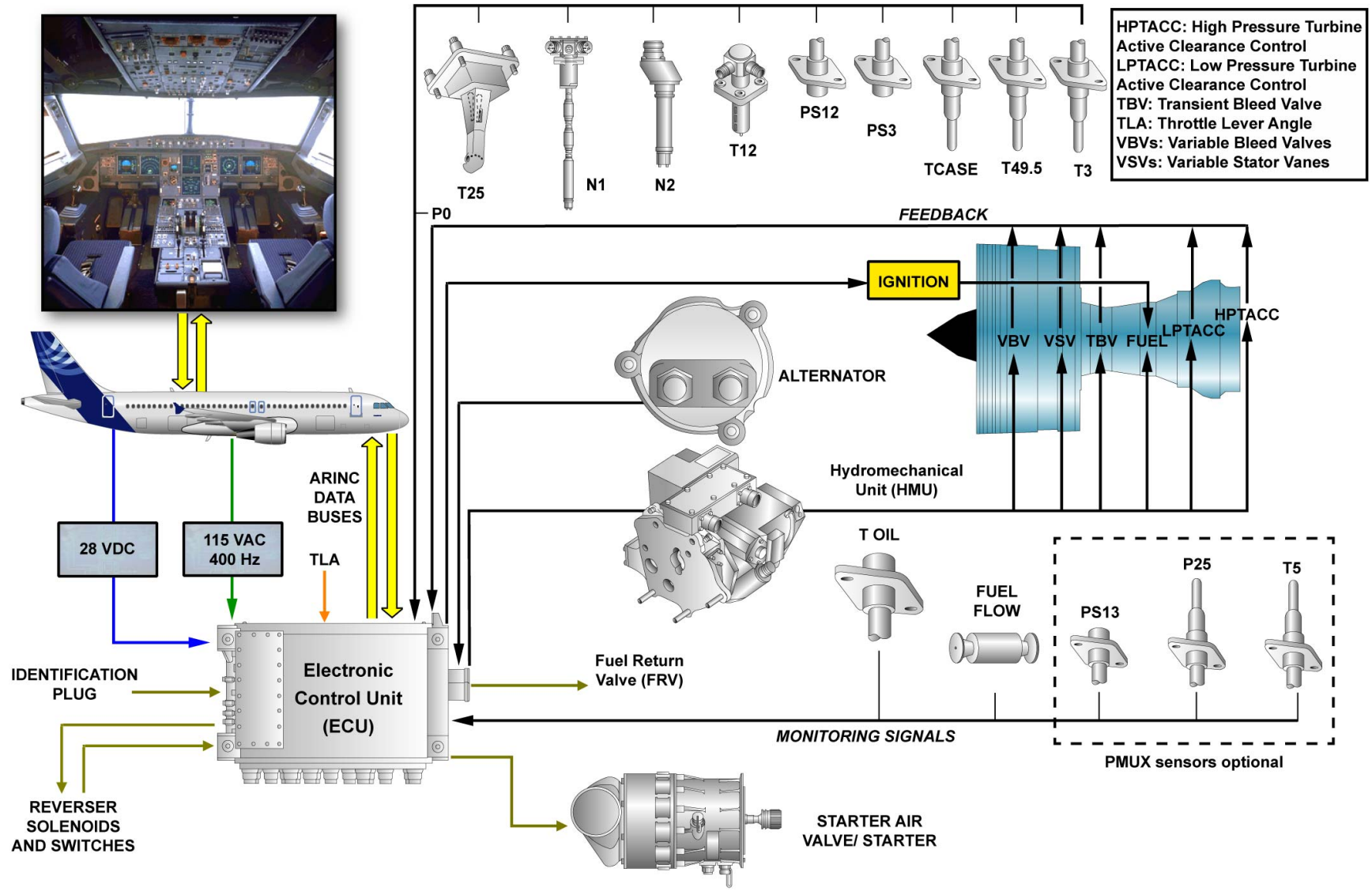
FADEC FUNCTIONS

The FADEC provides the regulation and scheduling of the engine systems to control the thrust and optimize engine operation.
The FADEC system performs engine control functions and engine/A/C integration.
The Engine control functions include:
- Power management control,
- Variable Bleed Valves (VBVs) control,
- Variable Stator Vanes (VSVs) control,
- Transient Bleed Valve (TBV) control,
- Fuel control regulation,
- High Pressure Turbine Active Clearance Control (HPTACC),
- Low Pressure Turbine Active Clearance Control (LPTACC),
- Fuel Return Valve (FRV) control.

Engine/A/C integration includes:
- Engine indication,
- Engine maintenance data,
- Automatic and manual starting,
- Thrust reverser control,
- Autothrust,
- Condition monitoring data.

POWER SUPPLY

Each ECU is powered by a three-phase permanent magnet alternator when the engine N2 > 58%. The FADEC Control Alternator provides an independent power supply to both ECU channels.



GENERAL ... POWER SUPPLY

UG913131 - U7RT0EC - UM73P1CFM000001

FADEC ARCHITECTURE (2)

DUAL CHANNEL

The Full Authority Digital Engine Control (FADEC) system is fully redundant and built around two independent Electronic Control Unit (ECU) channels - channel A and B. Each channel can control the different components of the engine.
Dual inputs, dual outputs, and automatic switch over from one channel to the other, eliminates any dormant failure.
Channels A and B are permanently operational. But only the channel in control, called the Active Channel, delivers output commands. The other channel is called the Stand-by channel. The selection of the Active and the Stand-by Channel is done at ECU power-up and during operation.

DUAL INPUTS

All control inputs to the FADEC system are dual. Only some secondary parameters used for monitoring and indicating are single.
To increase the fault tolerant design, the parameters are exchanged between the two control channels (inside the ECU) via the cross channel data link. Each channel can also operate independently, without cross channel data link.

HARDWIRED INPUTS

Most of the communication between the A/C systems and the ECU is transmitted over digital data buses.
In addition, some signals are hardwired directly from the A/C to the ECU.

DUAL OUTPUTS

All of the ECU control outputs are dual. The channel that is in control supplies the control signals to the various components such as torque motors and solenoids.
The other channel calculation is used for crosschecking.

BITE CAPABILITY

The ECU is equipped with a Built-in Test Equipment (BITE) system which provides maintenance information and test capabilities via the MCDU.

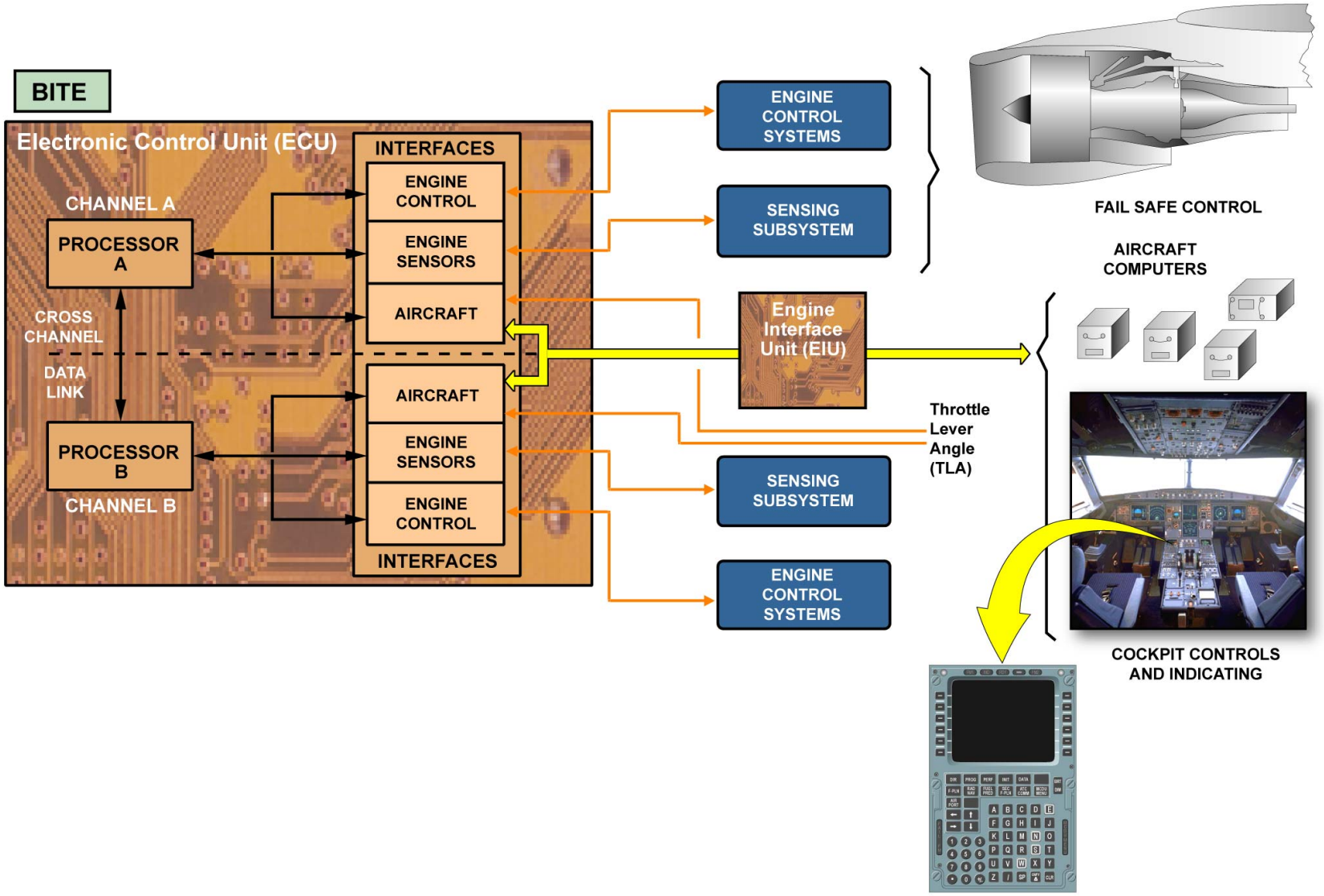
FAULT STRATEGY

The ECU can detect and isolate failures using the BITE system.
The BITE system allows each ECU channel to determine permanently its health status. The healthier channel is selected as the Active Channel. The other one is the Stand-by Channel. When both channels have the same health status, Active and Stand-by Channel selection alternates after every engine start.

FAIL SAFE CONTROL

If one channel is faulty, and the channel that is in control cannot ensure an engine component function, the component is moved to a fail-safe position.
Example: if one channel is faulty and the other channel is unable to control the Variable Bleed Valve (VBV) position, the VBVs are set to the fail-safe open position.

UG913131 - U7RT0EC - UM73P2CFM000001



DUAL CHANNEL ... FAIL SAFE CONTROL

FADEC ARCHITECTURE (2)

MAIN INTERFACES

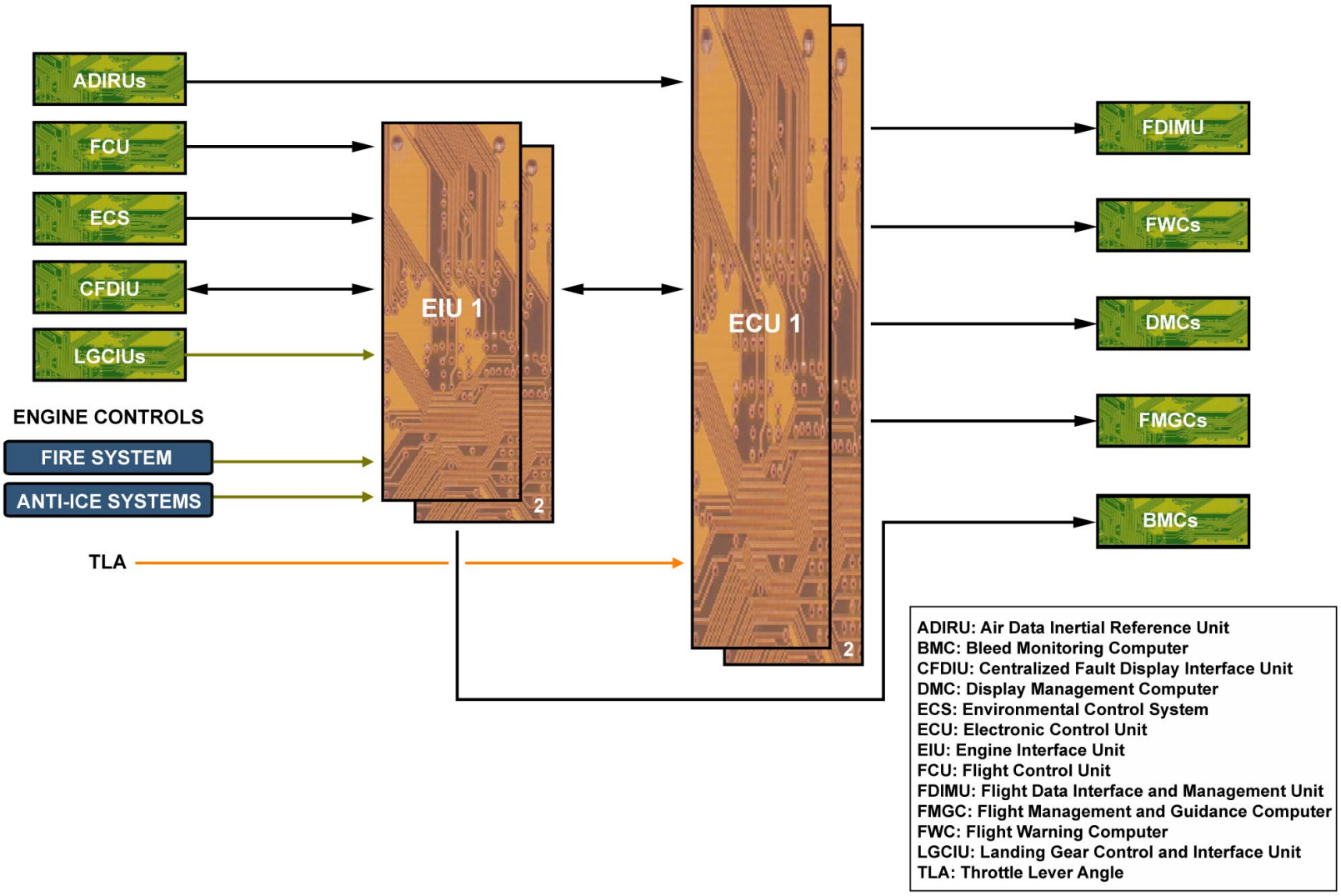
The ECU performs its tasks by interfacing with A/C system computers, either directly, or via the Engine Interface Unit (EIU). The EIU is an interface concentrator that serves as the communication link, between the A/C systems and the FADEC system. There is one EIU for each engine.

The ECU receives inputs from:

- Air Data Inertial Reference Units (ADIRUs),
- Flight Control Unit (FCU),
- Environmental Control System (ECS) computers,
- Centralized Fault Display Interface Unit (CFDIU),
- Landing Gear Control and Interface Units (LGCIUs),
- cockpit engine controls including fire, anti-ice systems and Throttle Lever Angle (TLA).

The ECU sends outputs to:

- Flight Data Interface and Management Unit (FDIMU),
- Flight Warning Computers (FWCs),
- Display Management Computers (DMCs),
- Flight Management and Guidance Computers (FMGCs),
- Centralized Fault Display Interface Unit (CFDIU),
- Bleed air Monitoring Computers (BMCs) through the EIU.



MAIN INTERFACES

FADEC PRINCIPLE (2)

GENERAL

The Full Authority Digital Engine Control (FADEC) system manages the engine thrust and optimizes the performance.

FADEC

The FADEC includes the Electronic Control Unit (ECU) and its peripheral components and sensors used for control and monitoring.
The ECU interfaces with the other A/C systems through the Engine Interface Unit (EIU).
The primary parameters (N1, N2, Exhaust Gas Temperature (EGT) and Fuel Flow (FF)) are sent by the ECU to the ECAM through DMCs.
Secondary parameters:
- the oil quantity and oil pressure are sent to the DMCs by the SDACs. If there is a failure of the SDACs, the EIU sends data to the DMCs by the FWCs,
- the oil temperature is sent by the EIU to the DMCs through the FWCs,
- the vibration parameters are sent by the EVMU to the DMCs through the SDACs.

ENGINE INTERFACE UNIT

Each EIU, located in the avionics bay, is an interface concentrator between the airframe and the corresponding ECU located on the engine.
There is one EIU for each engine. It interfaces with the corresponding ECU.

POWER MANAGEMENT

The FADEC provides automatic engine thrust control and thrust parameter limit computation.
The FADEC manages power according to two thrust modes:
- manual mode depending on Throttle Lever Angle (TLA),
- autothrust mode depending on autothrust function generated by the Auto Flight System (AFS).

The FADEC also provides two idle mode selections: Minimum idle and approach idle. If the aircraft is on ground and extend the slats the engine will stay at minimum idle but in flight it will go to approach idle. The idle can also be modulated up to approach idle depending on: Air conditioning demand, wing anti-ice demand, engine anti-ice demand and oil temperature (for Integrated Drive Generator (IDG) cooling).

ENGINE LIMIT PROTECTION

The FADEC provides overspeed protection for N1 and N2, in order to prevent the engine from exceeding certified limits and also monitors the EGT.

ENGINE SYSTEM CONTROL

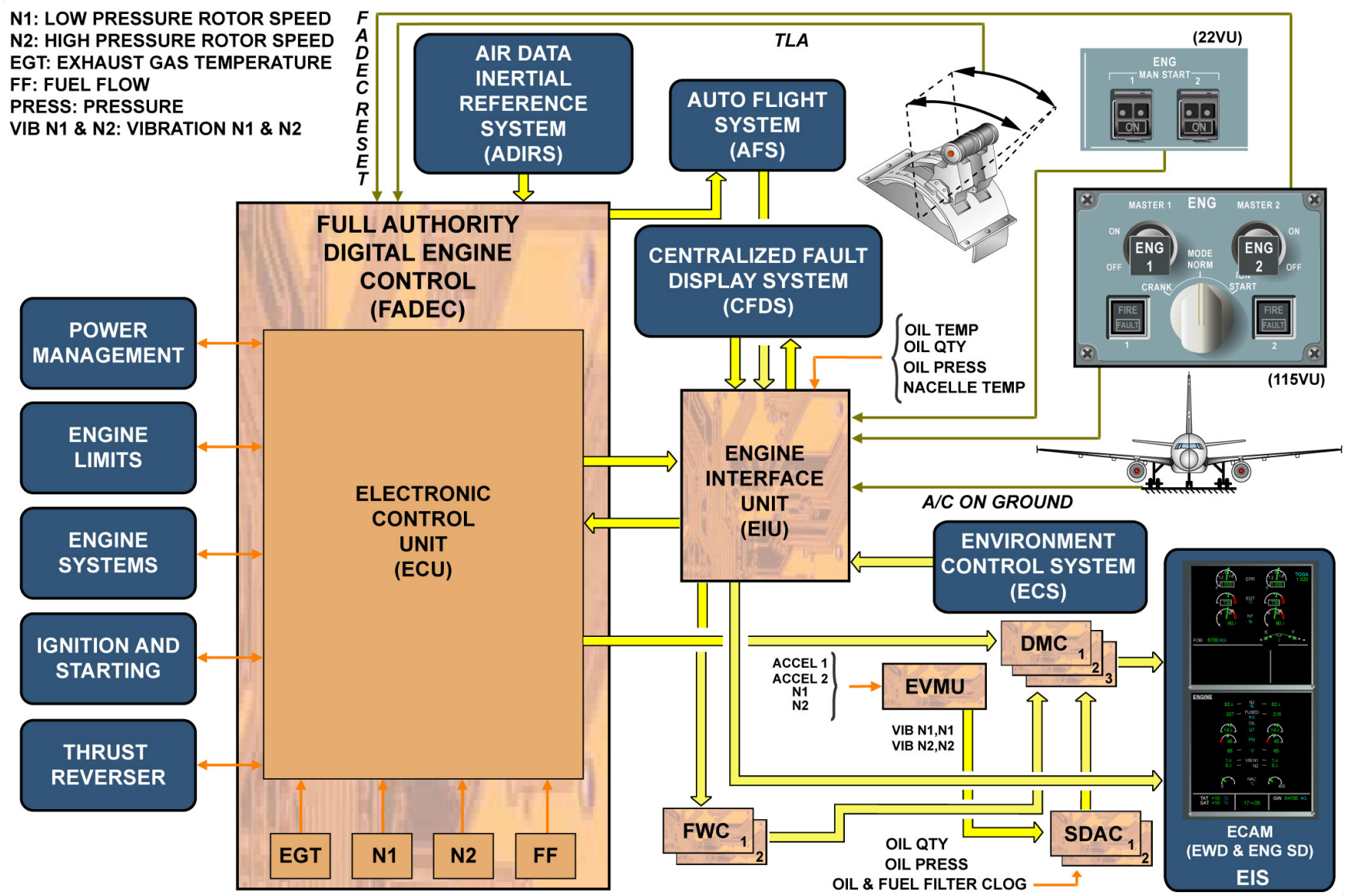
The FADEC provides optimal engine operation by controlling:
- FF,
- Turbine Clearance and Compressor Airflow.

STARTING AND IGNITION CONTROL

The FADEC controls the engine start sequence.
It monitors N1, N2, and EGT parameters and can abort or recycle an engine start.
The FADEC controls the starting and ignition in automatic mode when initiated from the ENG start panel (115 VU) or manual mode when initiated from the ENG MAN START panel.

THRUST REVERSER

The FADEC entirely supervises the thrust reverser operation.
In case of malfunction, the thrust reverser is stowed.



GENERAL ... THRUST REVERSER

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ECU INTERFACES (3)

GENERAL

The Electronic Control Unit (ECU) interfaces with various systems through channels A and B.

ECU CHANNEL A INPUTS

Channel A receives via bus network:
- The anemometric parameters for thrust calculation from the Air Data Inertial Reference System (ADIRS),
- The A/C command signals from the Engine Interface Unit (EIU) for engine control.

Each channel of the ECU receives a hardwired FADEC Reset signal from the Master Switch and the Autothrust instinctive disconnect signal from the push buttons on the throttle levers. The Throttle Control Unit sends the Throttle Resolver Angle (TRA). Each ECU also receives signals from engine sensors.
NOTE: The relationship between the Throttle Lever Angle (TLA) and TRA is linear and: 1 degree TLA is 1.9 degrees TRA.
The ECU is electrically supplied via the EIU only when N2 is below 58%. The ignition is supplied by 115 VAC.

ECU CHANNEL B INPUTS

Channel B receives ARINC data from the ADIRS as channel A. Data from the EIU, however, are received by channel A only and transmitted by the internal Cross Channel Data Link to channel B. The hardwired discrete and analog input signals are the same as for channel A: FADEC Reset, instinctive disconnect signal and TRA.

ECU CHANNEL A OUTPUTS

Channel A provides outputs via ARINC buses to the: EIU, Flight Data Interface and Management Unit (FDIMU) - DMU part, Flight Warning Computers (FWCs), Display Management Computers (DMCs), Flight Management and Guidance Computers (FMGCs).
Channel A also provides outputs to the engine controls (torque motors and solenoids).

ECU CHANNEL B OUTPUTS

Channel B provides outputs via ARINC buses to the: EIU, FWCs, DMCs, and FMGC. It also provides outputs to the engine controls.

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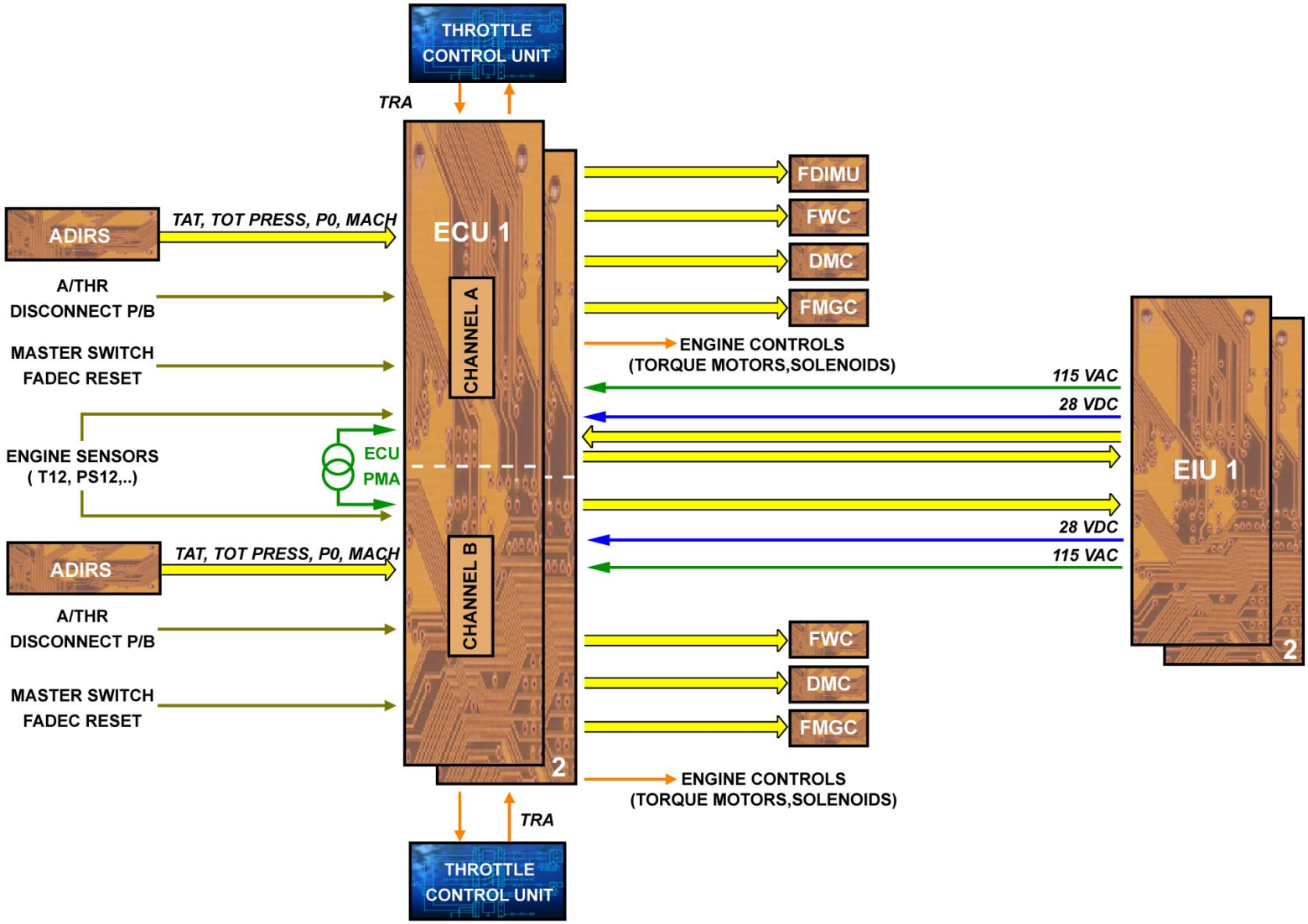

GENERAL ... ECU CHANNEL B OUTPUTS

EIU INTERFACES (3)

INPUTS

The Engine Interface Unit (EIU) receives digital, discrete and analog inputs.

DIGITAL INPUTS

The Engine Interface Unit (EIU) receives digital inputs from:
- the Centralized Fault Display Interface Unit (CFDIU) for engine troubleshooting and test,
- the Air Conditioning System Controller (ACSC), for bleed air demands of the air conditioning system,
- and the Flight Control Unit (FCU) for the auto-thrust function.

The EIU also receives data from each channel of the Electronic Control Unit (ECU).

DISCRETE INPUTS

The EIU receives command signals from the following control panels:
- wing anti-ice,
- Engine anti-ice,
- Full Authority Digital Engine Control (FADEC) ground power panel,
- Engine fire panel,
- Engine start panel,
- Throttle Control Unit thrust reverser microswitch.
- Engine manual start panel

It also receives specific signals of A/C configuration from the following computers:
- Landing Gear Control Interface Unit (LGCIU),
- Slat and Flap Control Computer (SFCC),
- Fuel Level Sensing Control Unit (FLSCU).

OTHER DISCRETE INPUTS

Other discrete inputs are provided for the engine oil low pressure warning.

ANALOG INPUTS

The EIU receives analog signals corresponding to values of secondary parameters from engine sensors, for display on the ECAM engine page.

OUTPUTS

The EIU sends digital and discrete outputs.

DIGITAL OUTPUTS

The EIU sends digital outputs to:
- the Bleed Monitoring Computer (BMC) for pneumatic valve operation,
- the Flight Warning Computers (FWC) for alarms and indication,
- and, the Centralized Fault Display Interface Unit, (CFDIU) for fault messages.

Other digital outputs are sent to channel A and channel B of the ECU.

DISCRETE OUTPUTS

The EIU provides the following discrete outputs to other A/C systems for some required commands and specific engine operations:
- start valve closure,
- thrust reverser inhibition,
- APU boost demand,
- oil low pressure on ground,
- HP fuel Shut-off Valve (SOV) closed,
- N2 at or above minimum idle,
- Throttle Lever Angle (TLA) in takeoff position,
- engine FAULT light on.

SUPPLY MODULE

The EIU contains a power supply module that is used to supply electrical power to the ECU and the ignition systems.

NOTE: If the EIU electrical power is lost, the EIU fails and engine start or restart is not possible.

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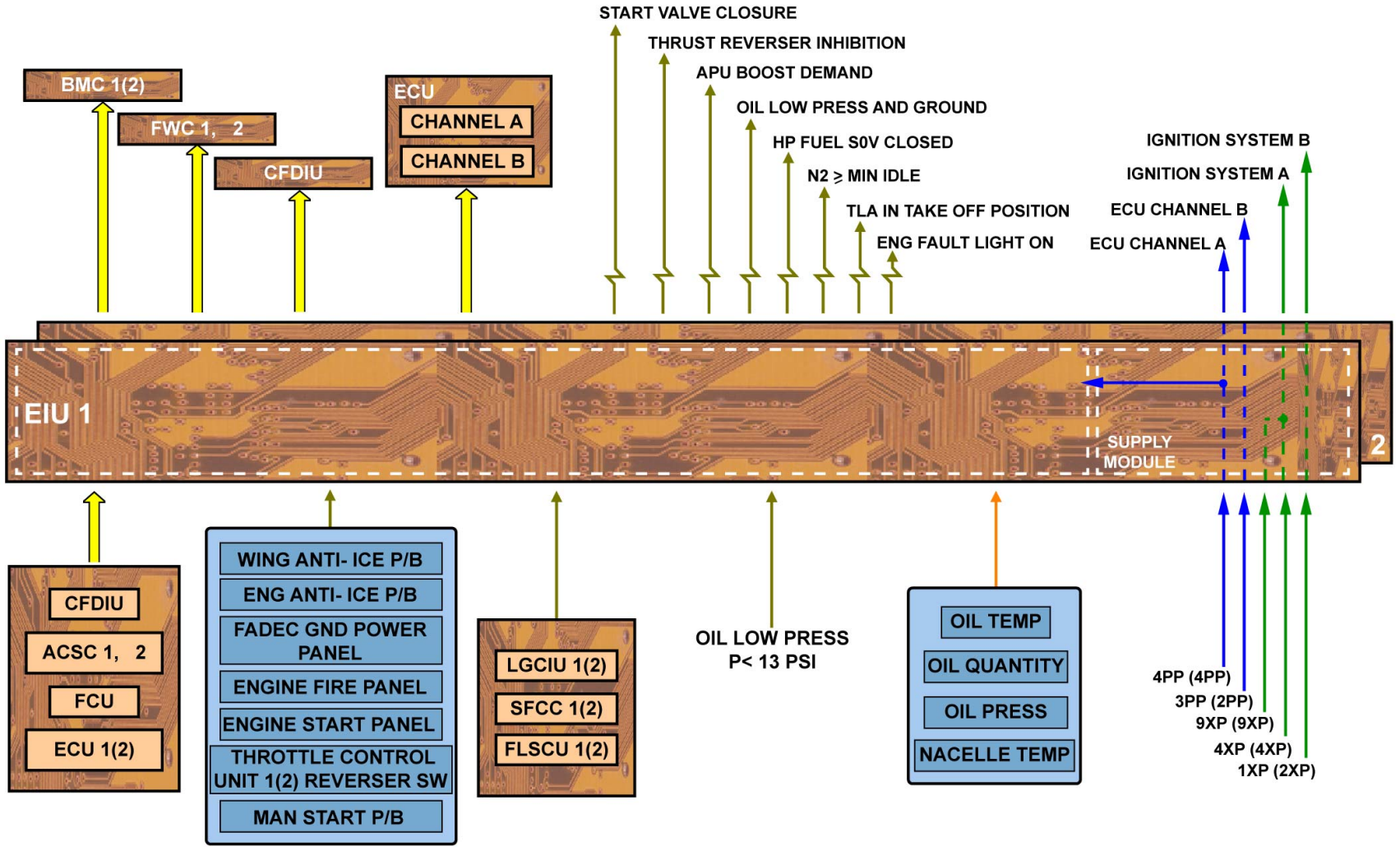

INPUTS ... SUPPLY MODULE

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UG913131 - U7RT0EC - UM73D4CFM000001

ECU ELECTRICAL PWR SPLY CONTROL (3)

GENERAL

The Electronic Control Unit (ECU) is supplied from the aircraft electrical power when the engine is shut down or when N2<58%. The Permanent Magnet Alternator (PMA), which is also called Control Alternator, supplies the ECU when the engine is running and N2>58%.

POWERING N2<58%

Each channel is independently supplied by the aircraft 28 VDC through the Engine Interface Unit (EIU). At initial A/C power-up, both engine ECUs are supplied with aircraft power for 5 minutes.
Aircraft 28 VDC is used for:
- power-up check of the Full Authority Digital Engine Control (FADEC) before engine start,
- engine starting,
- powering the ECU while the engine is running below 58% N2.

Note that the EIU takes its power from the same bus bar as the ECU.

POWERING N2>58%

As soon as the engine is running above 58% of N2, the Control Alternator supplies the ECU.
The PMA supplies each channel with three-phase AC power. Two transformer rectifiers provide 28 VDC power supply to channels A and B.
Above 58% of N2, the ECU logic automatically switches to the control alternator supply. In case of control alternator failure, the ECU will automatically switch over the 28VDC power supply from the aircraft network, available as a back-up through the EIU.

AUTO DE-POWERING

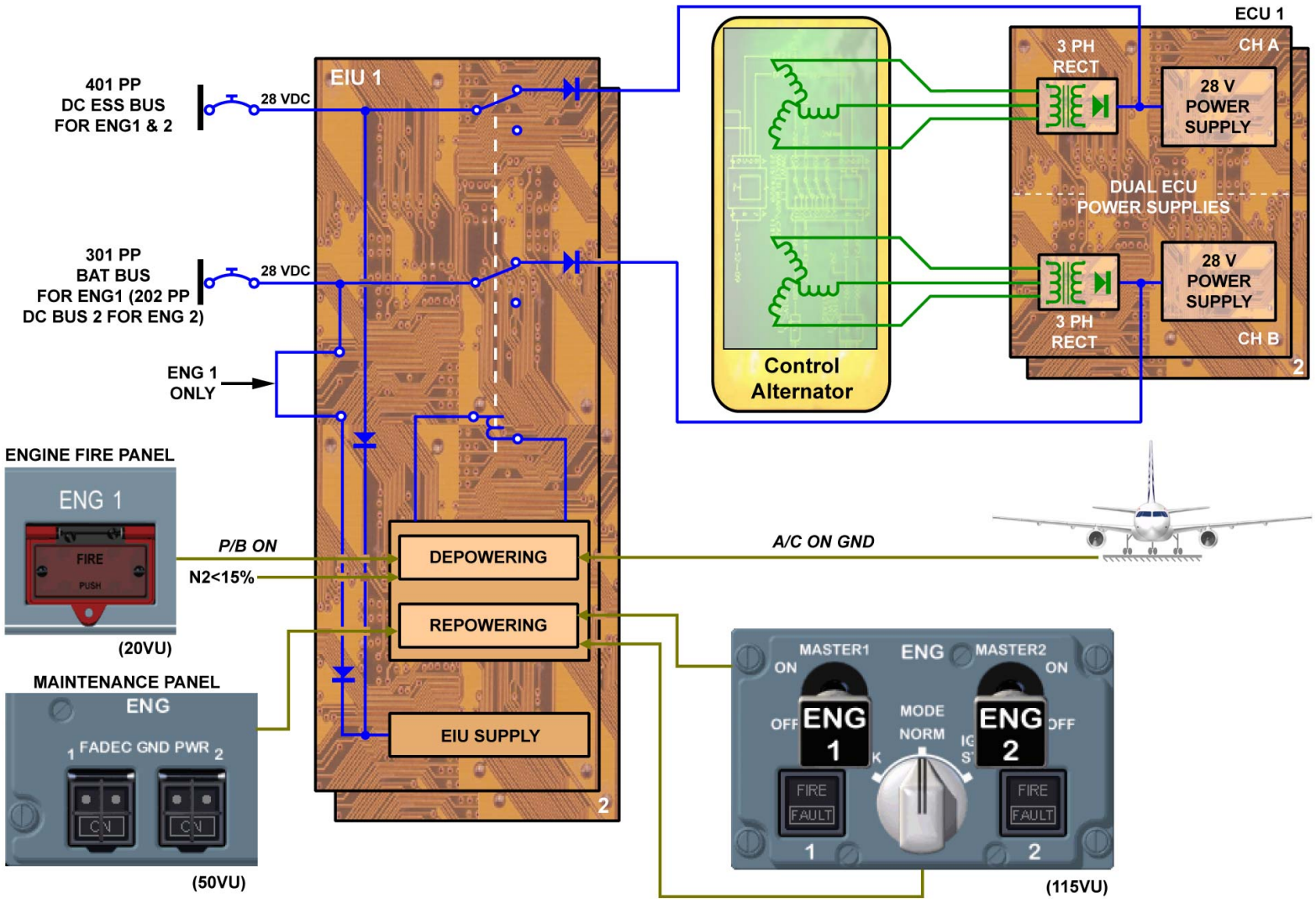
The FADEC is automatically de-powered on the ground, through the EIU, after engine shutdown.

ECU automatic de-powering on the ground by the EIU:
- five minutes after aircraft power up,
- five minutes after engine shut down (M/S to OFF) to get continued engine maintenance data transmission.

Note that releasing the ENGine FIRE P/B out provides ECU power cut off from the aircraft network.

FADEC GROUND POWER PANEL

For maintenance purposes and MCDU engine tests, the ENGine FADEC GrouND PoWeR P/B on the MAINTenance panel (50VU) permits FADEC power supply to be restored on the ground with engine shut down.
The EIU supplies power to the FADEC as long as the GND PWR P/B is in the ON position.
Also note that the FADEC is repowered as soon as the engine start selector is selected to CRANK or IGNition START or the MASTER switch is selected ON.



GENERAL ... FADEC GROUND POWER PANEL

IGNITION & STARTING SYSTEM PRESENTATION (2)

GENERAL

The ignition system supplies the electrical spark needed to start or continue engine combustion. It is comprised of two independent subsystems. Each subsystem includes:
- a spark igniter,
- a fan air cooled coaxial shielded ignition lead,
- an ignition exciter.

The pneumatic starting system drives the engine High Pressure (HP) rotor up to and above the engine self-sustaining speed for initial starting on ground or supports an engine re-light in flight if required. The start system is made of the pneumatic starter Shut-Off Valve (SOV) and the pneumatic starter.

CONTROL AND INDICATING

The Electronic Control Unit (ECU) controls the ignition and starting systems either in automatic or manual mode.
The operation of the pneumatic starter SOV and of the ignition system is displayed on the ECAM ENGINE page.

AUTOMATIC START

During an automatic start, the ECU opens the pneumatic starter SOV, then one of the two ignition exciter is energized when the HP rotor reaches 16% of N2 speed.
The ECU gives full protection during the start sequence. When the HP rotor has reached 50% of N2, the ECU closes the pneumatic starter SOV and cuts off ignition. In case of an incident during the automatic start the ECU aborts the start procedure.

MANUAL START

During a manual start, the pneumatic starter SOV opens when engine MANual START P/B is pressed in, then the ignition system is energized when the MASTER switch is set to the ON position.
Note that also a manual start can be automatically aborted in case of EGT overlimit or compressor stall detection.
Then the fuel is cut off and the engine will dry crank.

CRANKING

Engine motoring could be performed for dry cranking or wet cranking sequences.
During cranking, ignition is inhibited.

CONTINUOUS IGNITION

With engine running, continuous ignition can be selected via the ECU either manually using the rotary selector or automatically by the Full Authority Digital Engine Control (FADEC).

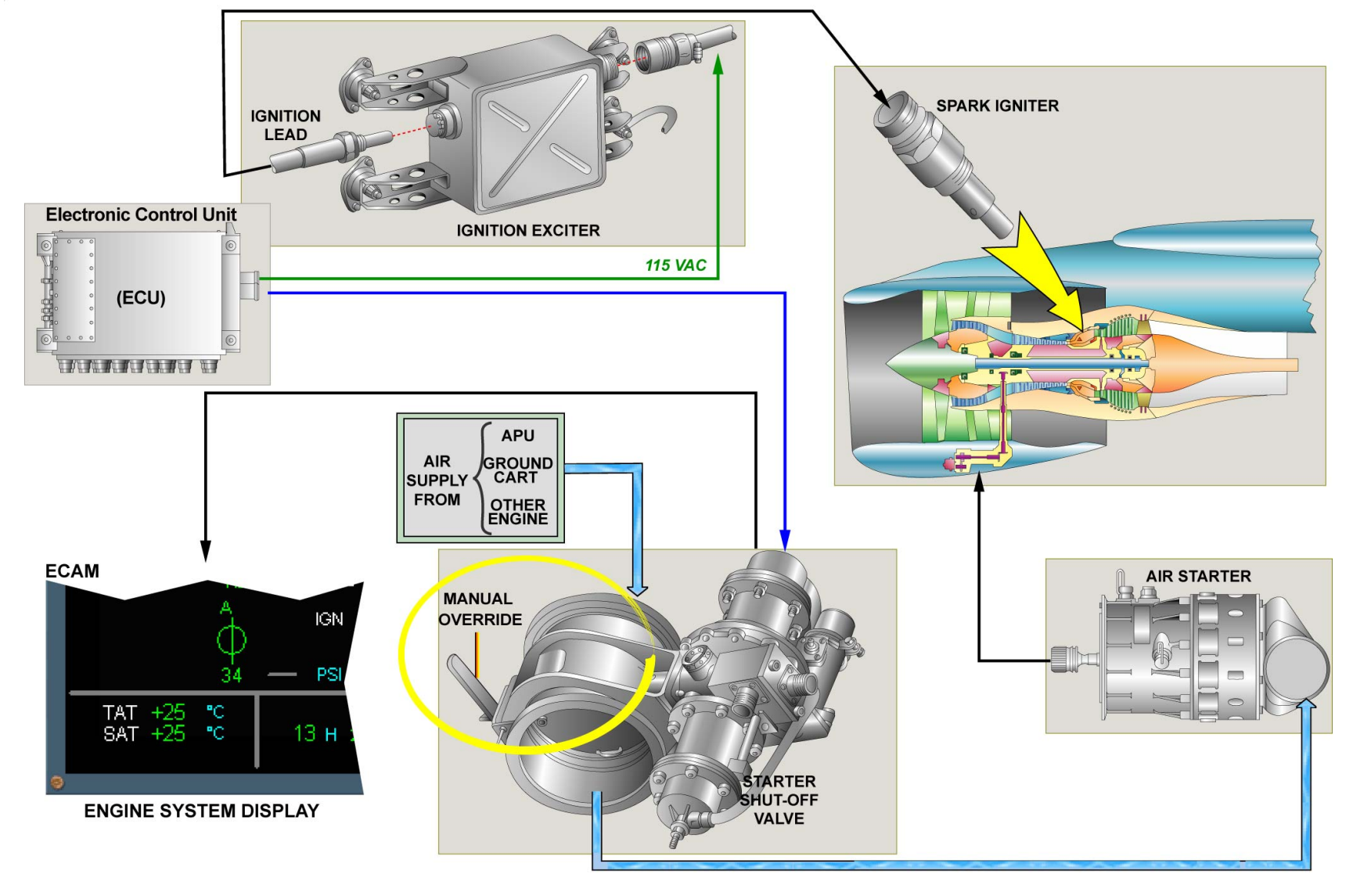
SAFETY PRECAUTIONS

Safety precautions have to be taken prior to working in this area.

WARNING: the ECU sends 115 volts to the ignition exciters, which converts it and sends high voltage, high-energy pulses through the ignition leads to the spark igniters.

MAINTENANCE PRACTICES

To increase aircraft dispatch reliability, the pneumatic starter SOV is equipped with a manual override. For this manual operation, the mechanic has to be aware of the engine safety zones.



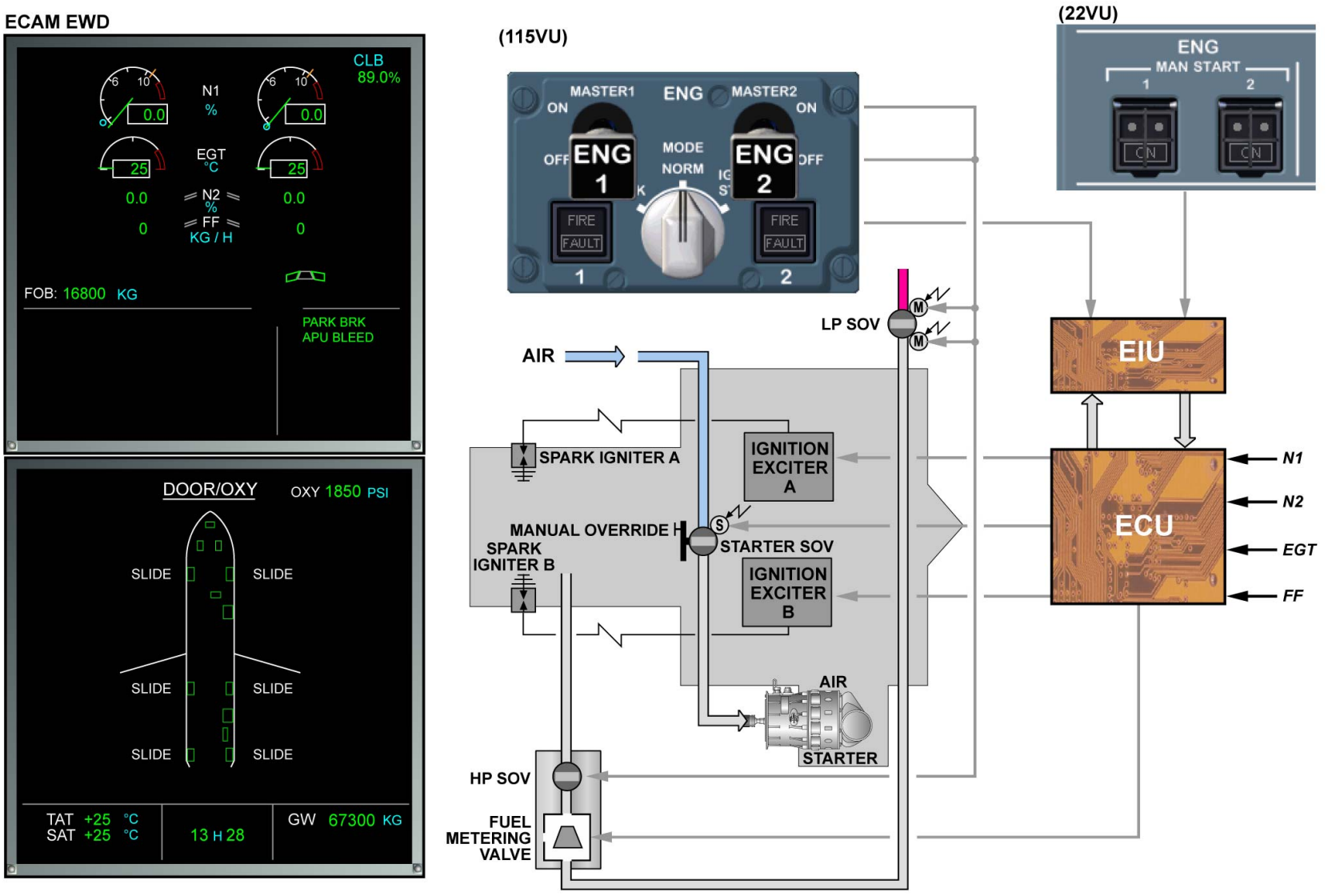
GENERAL ... MAINTENANCE PRACTICES

IGNITION & STARTING SYSTEM D/O (ME) (3)

GENERAL

The Electronic Control Unit (ECU) controls and monitors the start sequence either in automatic or manual mode.
In automatic mode the ECU is able, up to 50% N2, to abort the start sequence in case of an incident such as:
- starter Shut-Off Valve (SOV) failure,
- ignition failure,
- High Pressure (HP) fuel SOV failure,
- hot start,
- hung start or,
- engine stall.

The system consists of a starter SOV, an air starter, two ignition exciters, spark igniters (A and B) and two ignition leads.
The starter SOV is fitted with a manual override handle for manual operation in case of electrical SOV failure.
On the enhanced system, the same information is provided with a different display presentation.


ECAM EWD
CLB
89.0%
N1
%
0.0
0.0
EGT
°C
25
25
0.0
0.0
N2
%
FF
KG / H
0
0
FOB: 16800 KG
PARK BRK
APU BLEED
DOOR/OXY
OXY 1850 PSI
SLIDE
SLIDE
SLIDE
SLIDE
SLIDE
SLIDE
TAT +25 °C
SAT +25 °C
13 H 28
GW 67300 KG
(115VU)
MASTER1
ENG
MASTER2
ON
ON
OFF
ENG 1
MODE
NORM
ENG 2
OFF
FIRE
FAULT
FIRE
FAULT
1
2
(22VU)
ENG
MAN START
1
2
CN
CN
LP SOV
AIR
EIU
SPARK IGNITER A
IGNITION EXCITER A
MANUAL OVERRIDE
SPARK IGNITER B
STARTER SOV
IGNITION EXCITER B
ECU
N1
N2
EGT
FF
AIR
STARTER
HP SOV
FUEL METERING VALVE

GENERAL

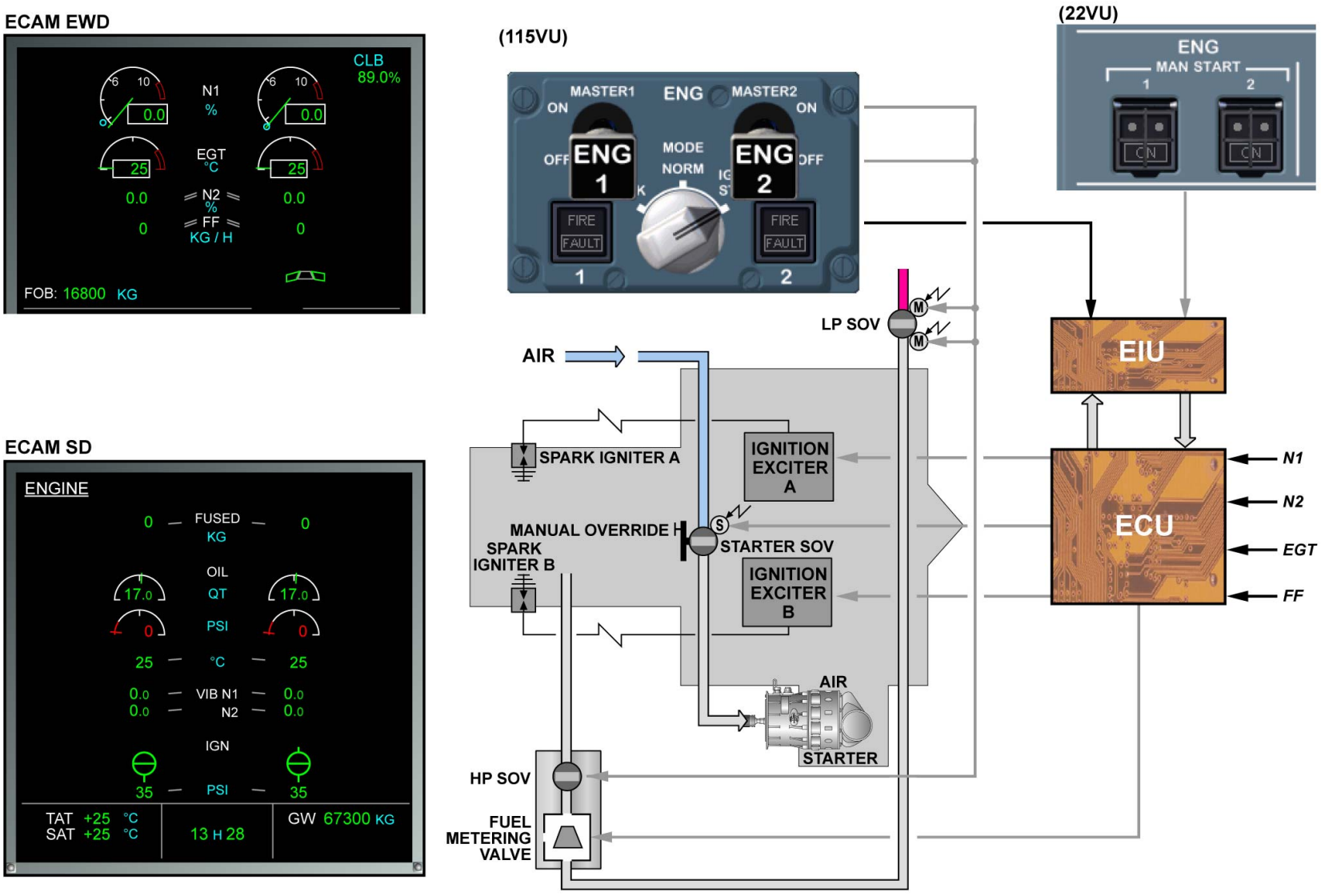
IGNITION & STARTING SYSTEM D/O (ME) (3)

AUTOMATIC START

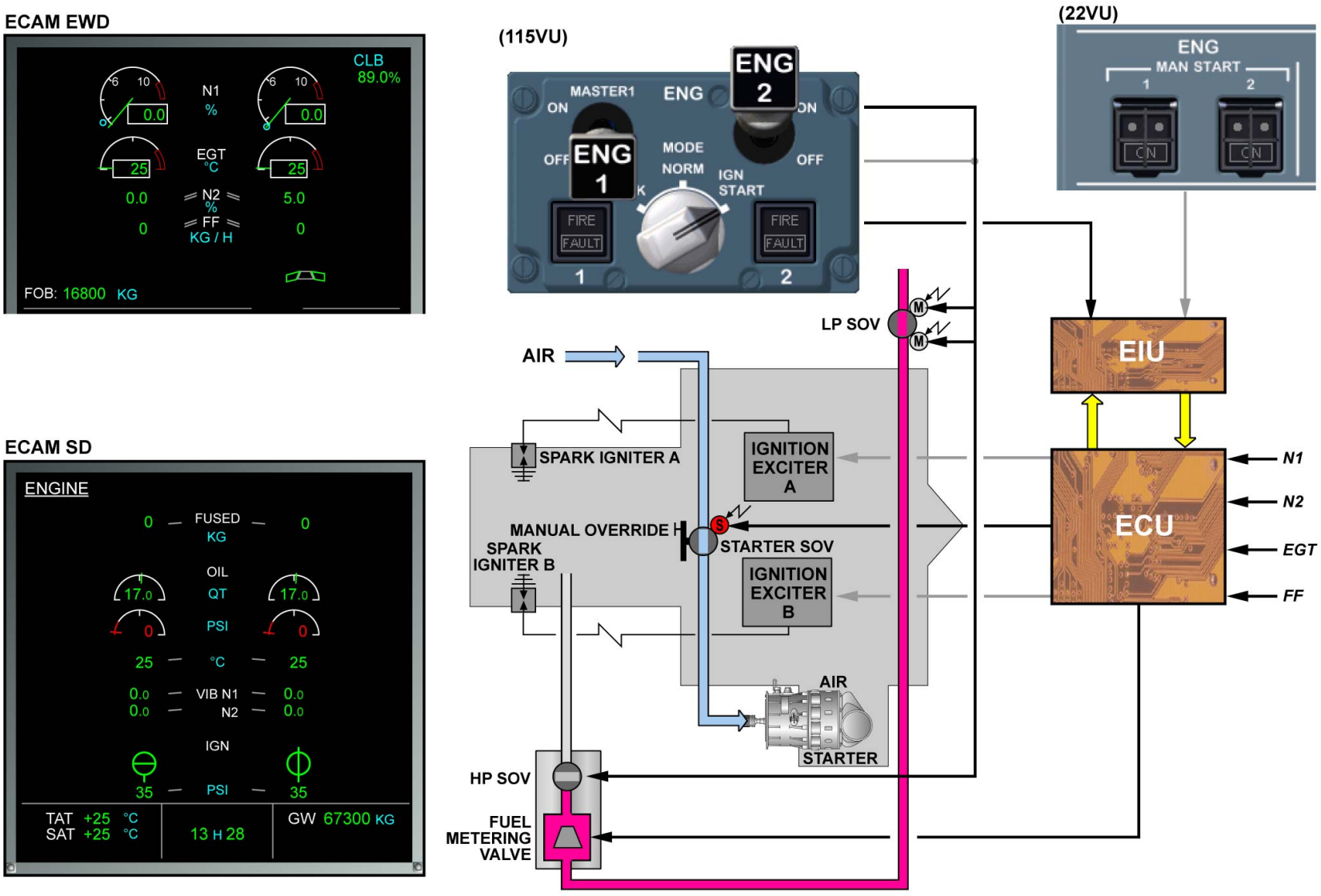
Start sequence in automatic mode.
The aircraft configuration in this case is the following:
- APU running and APU BLEED on,
- Full Authority Digital Engine Control (FADEC) 1 and 2 powered.

When IGNition START is selected the ENGINE page is called automatically. During engine start, the ENGINE page includes IGN indication, starter SOV position and bleed pressure.
During this time the pack valves are automatically closed. If, after 30 seconds, the ENGine MASTER control switch is not switched to ON position, the pack valves will re-open.
As soon as the ENGine MASTER control switch is set to ON position, the Low Pressure (LP) fuel SOV opens and the ECU opens the starter SOV. The position of this valve is confirmed on the ECAM and the N2 begins to increase.
When N2 reaches 16% the ECU provides ignition. The selection of the spark igniter is a function of the ECU and at each start the igniter selection will be changed.
At 16% of N2, on the ENGINE page, the corresponding spark igniter system (A or B) chosen by the ECU is displayed.
When N2 reaches 22% the ECU controls, through the Fuel Metering Valve (FMV), HP fuel SOV opening. At this percentage of N2, fuel flow begins.
The ECU monitors the Exhaust Gas Temperature (EGT) and N2 according to their schedules to provide the correct fuel flow. The maximum EGT during start sequence is 725º C.
In case of malfunction the ECU automatically shuts down the engine and performs a dry motoring sequence.
Up to 50% N2, the automatic fuel flow regulation is performed. At 50% N2, the ECU closes the starter SOV and cuts off the ignition.
The pack valves re-open if another engine is not started within 30 seconds.
Engine 2 is now stabilized at minimum idle.
To start the second engine, you set the MASTER control switch 1 to ON keeping the selector in the IGNition START position.
To complete this start sequence the selector is set back to MODE NORMal position. With the selector in this position and at least one engine running, the WHEEL page appears instead of the ENGINE page.
If IGNition START is re-selected, continuous ignition is initiated on the running engines.
At any time, if the MASTER lever is set to OFF, the start sequence or the engine operation is stopped because the MASTER control switch directly energizes the HP fuel SOV solenoid. With the MASTER control switch at OFF, the LP and HP SOVs are closed.
With both engines shut down, the DOOR/OXYgen page is displayed.

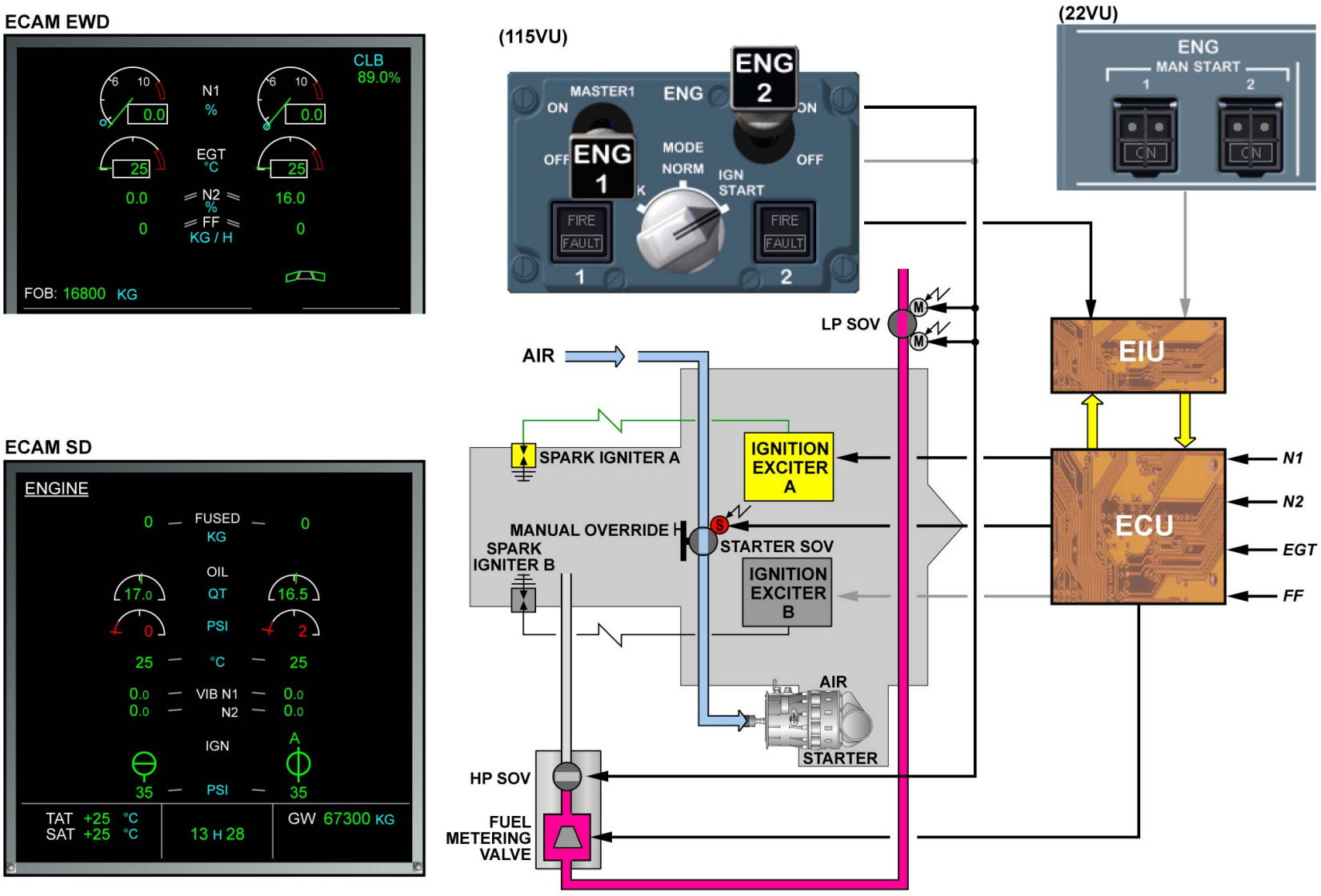
UG913131 - U7RT0EC - UM74D1CFM000001



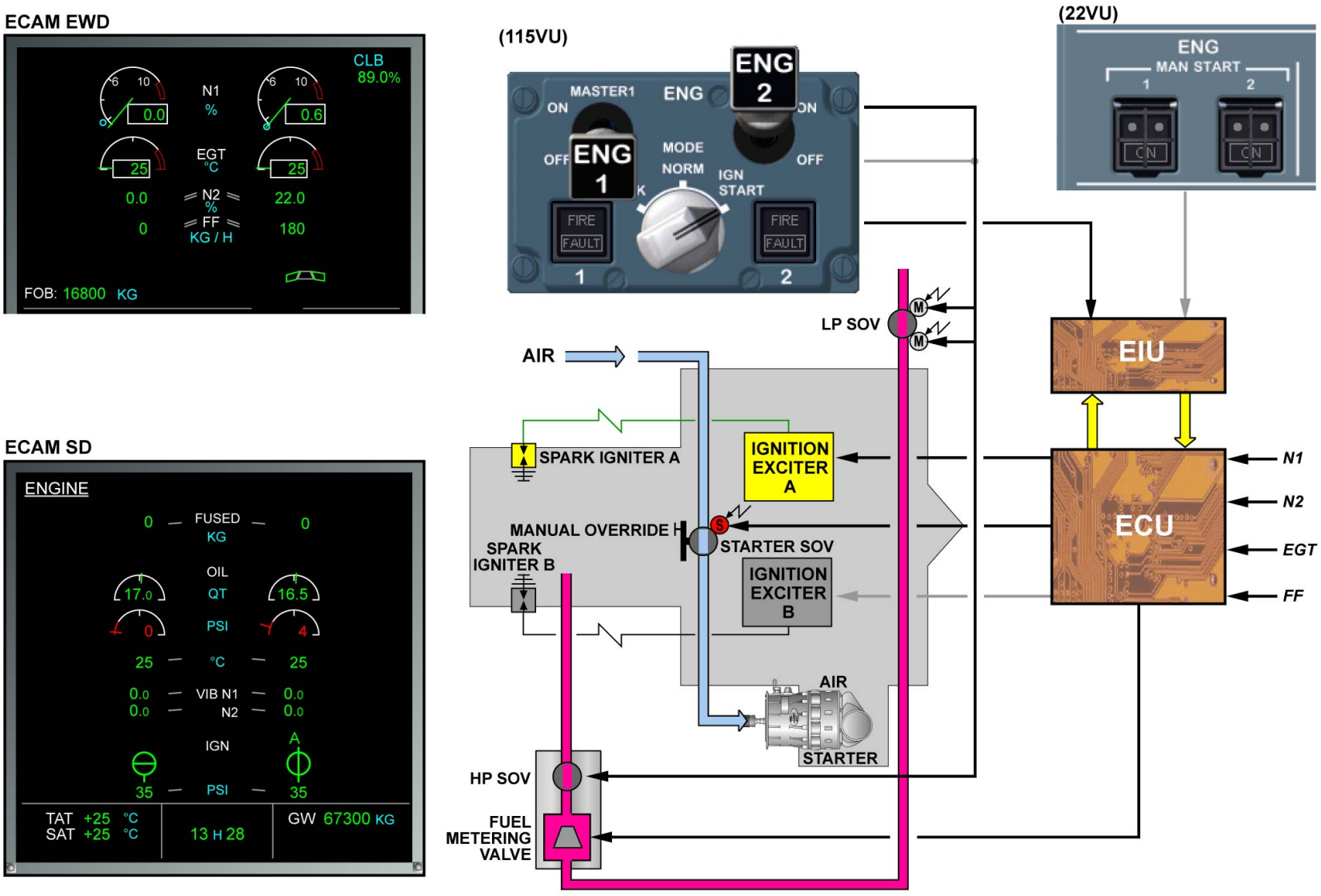
AUTOMATIC START



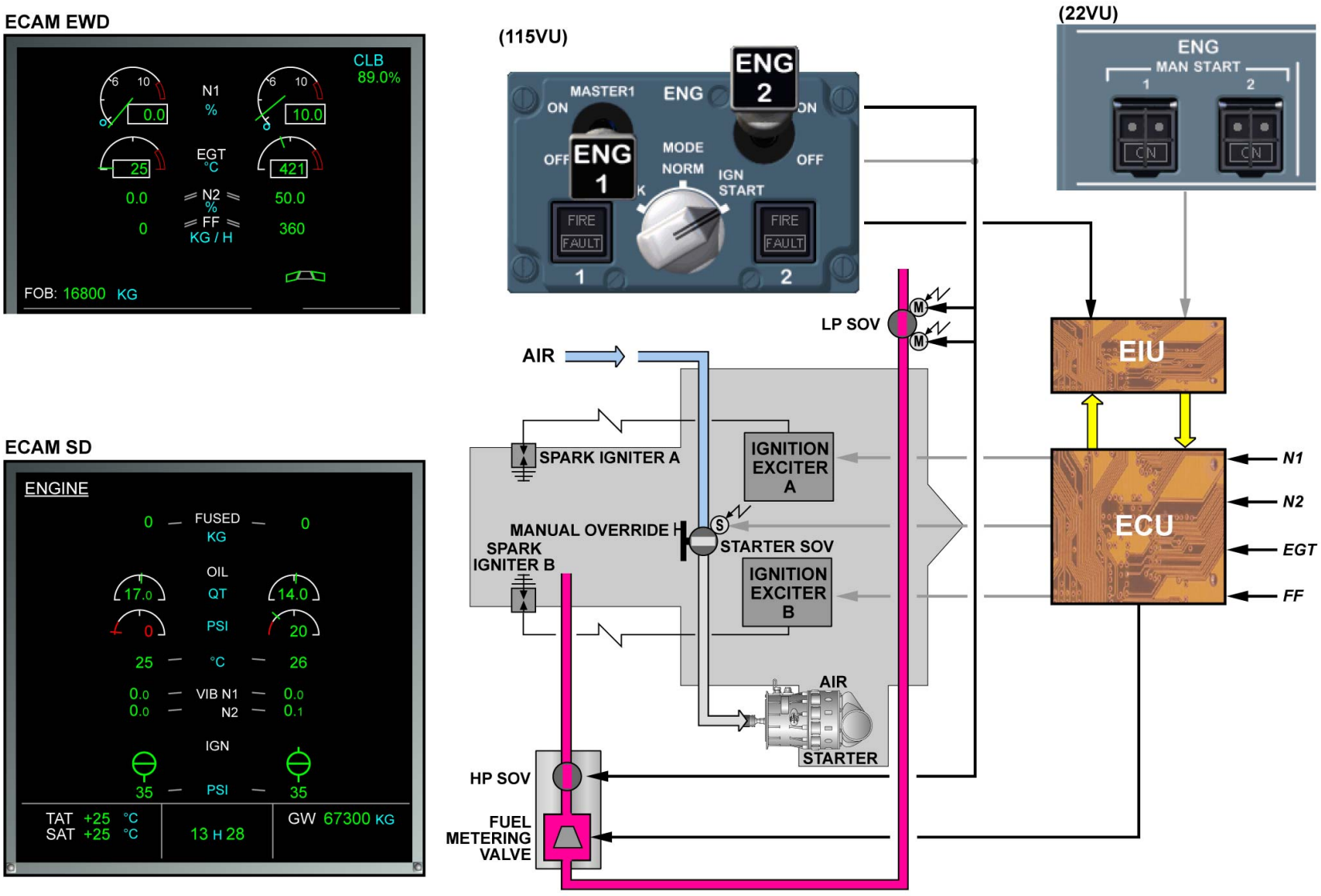
AUTOMATIC START



AUTOMATIC START



AUTOMATIC START



AUTOMATIC START

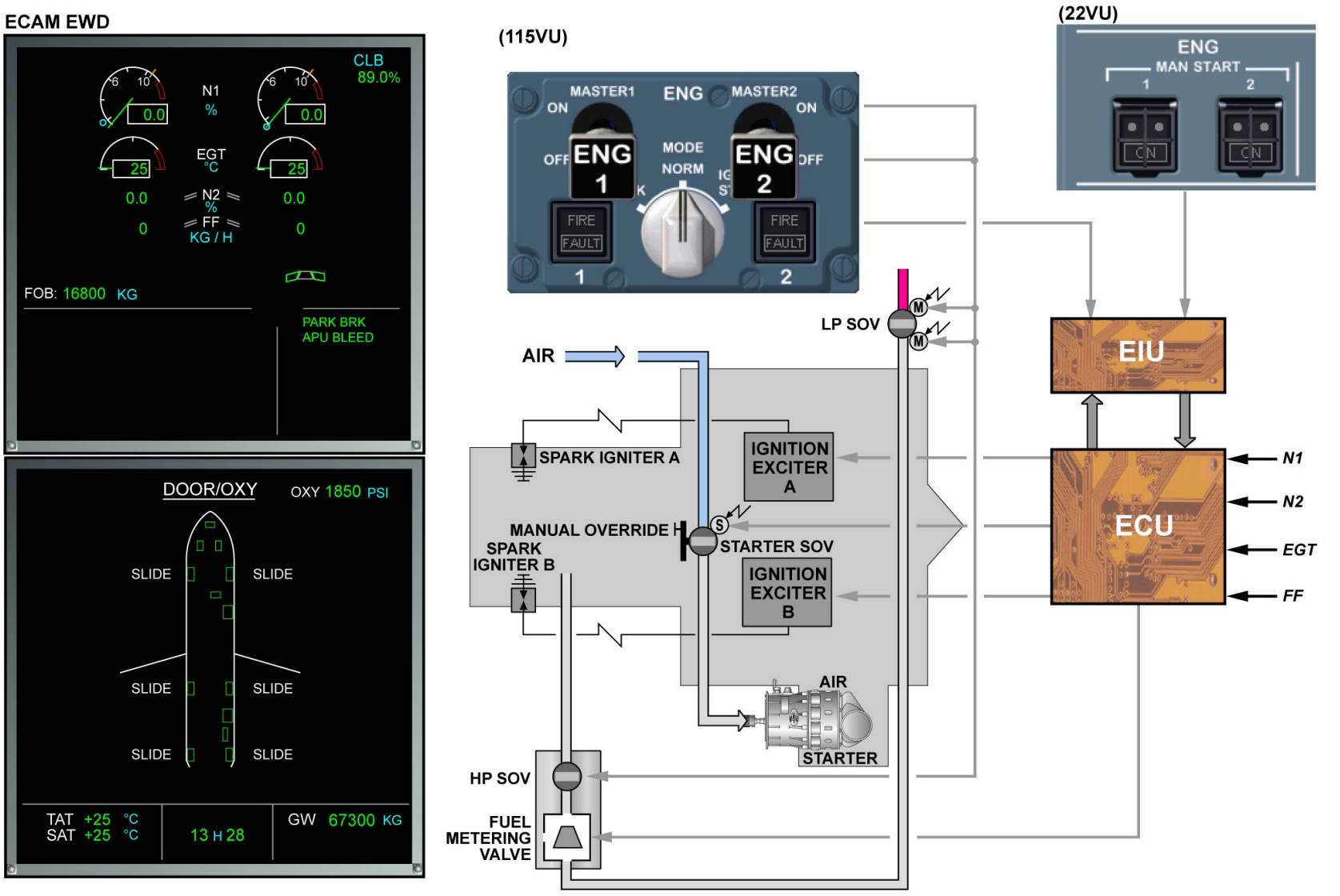
IGNITION & STARTING SYSTEM D/O (ME) (3)

MANUAL START

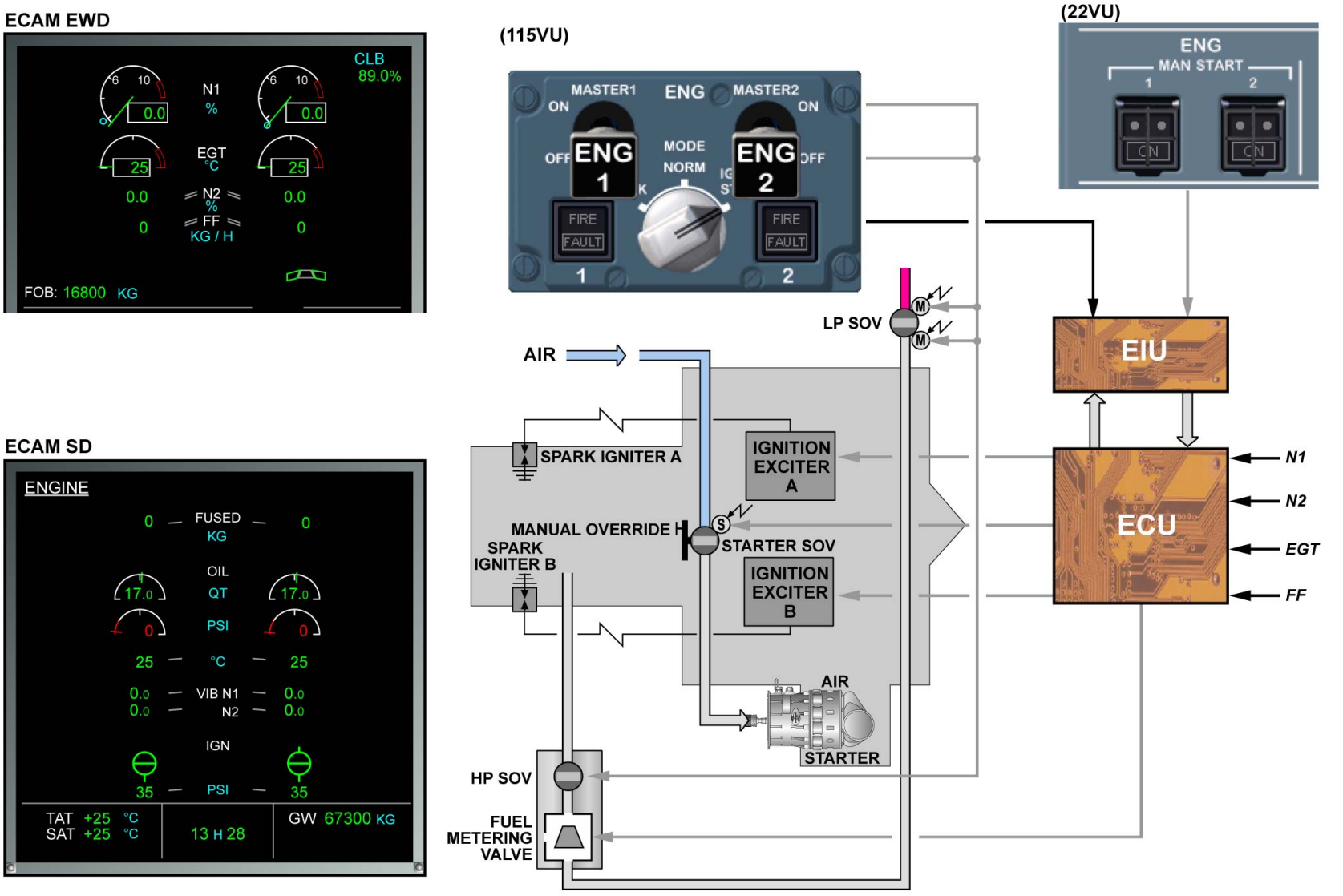
Start sequence in manual mode.
The aircraft configuration:
- APU running and APU BLEED on,
- FADEC 1 and 2 powered.

When IGNition START is selected the ENGINE page is called automatically. During start the ENGINE page displays IGN indication, starter SOV position and bleed pressure.
During this time the pack valves are automatically closed. If, after 30 seconds, the ENGine MANual START P/B is not switched ON, the pack valves will re-open.
Selecting the ENGine MANual START P/B opens the starter SOV. After that, the N2 begins to increase and, when it is at least 20% N2, the MASTER control switch must be set to the ON position.
Before the MASTER control switch is set to ON, it is possible to interrupt the sequence by selecting the MANual START P/B switch to OFF.
As soon as the MASTER control switch is set to the ON position, both ignition systems are energized, LP and HP SOV are opened and fuel flow increases.
At 20% of N2 with the MASTER control switch at ON, dual ignition and fuel flow are initiated.
The ECU monitors the EGT and N2, according to their schedules, to provide the correct fuel flow. The maximum EGT during start sequence is 725º C.
In case of malfunction, set the MASTER control switch to OFF to perform a start abort sequence. In manual starts there is no automatic shutdown function.
Up to 50% of N2, the automatic fuel flow regulation is performed. When N2 reaches 50%, the ECU automatically closes the starter SOV and cuts off the ignition.
The pack valves re-open after 30 seconds.
Engine 2 is now stabilized at minimum idle.
To start the other engine, set the ENGine 1 MANual START P/B to ON, keeping the selector in the IGNition START position and then, when N2 reaches 20%, set the MASTER control switch 1 to ON.
After engine start, the selector is set back to MODE NORMal position.
With the selector in this position and one engine running, the WHEEL page appears instead of the ENGINE page.
If IGNition START is re-selected, continuous ignition is initiated on the running engine(s).
To complete the start sequence, the MANual START P/B is released out.
The action on the MANual START P/B has no effect on the starter SOV which has already been automatically closed at 50% of N2, it is only done to complete the manual start procedure.

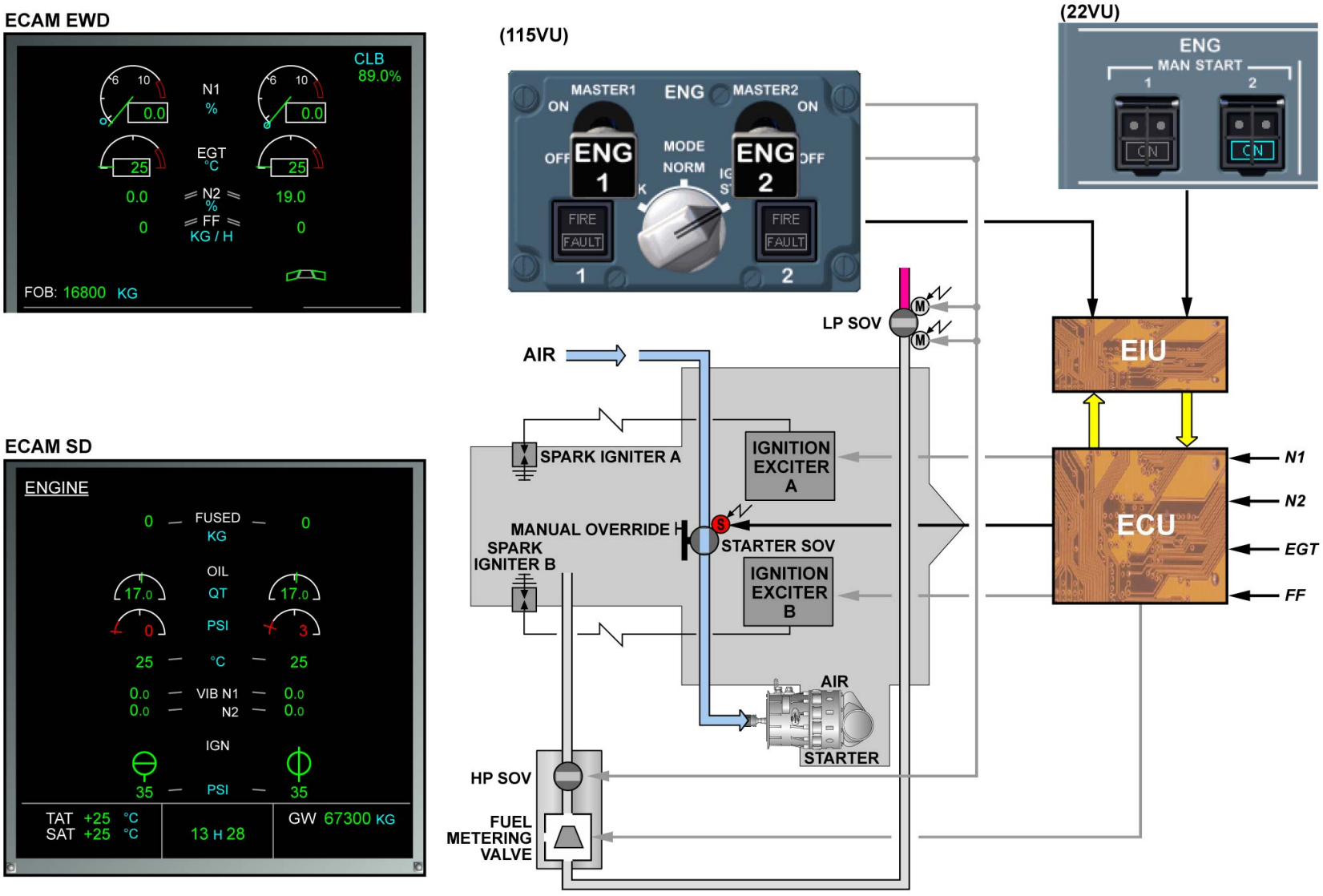
UG913131 - U7RT0EC - UM74D1CFM000001



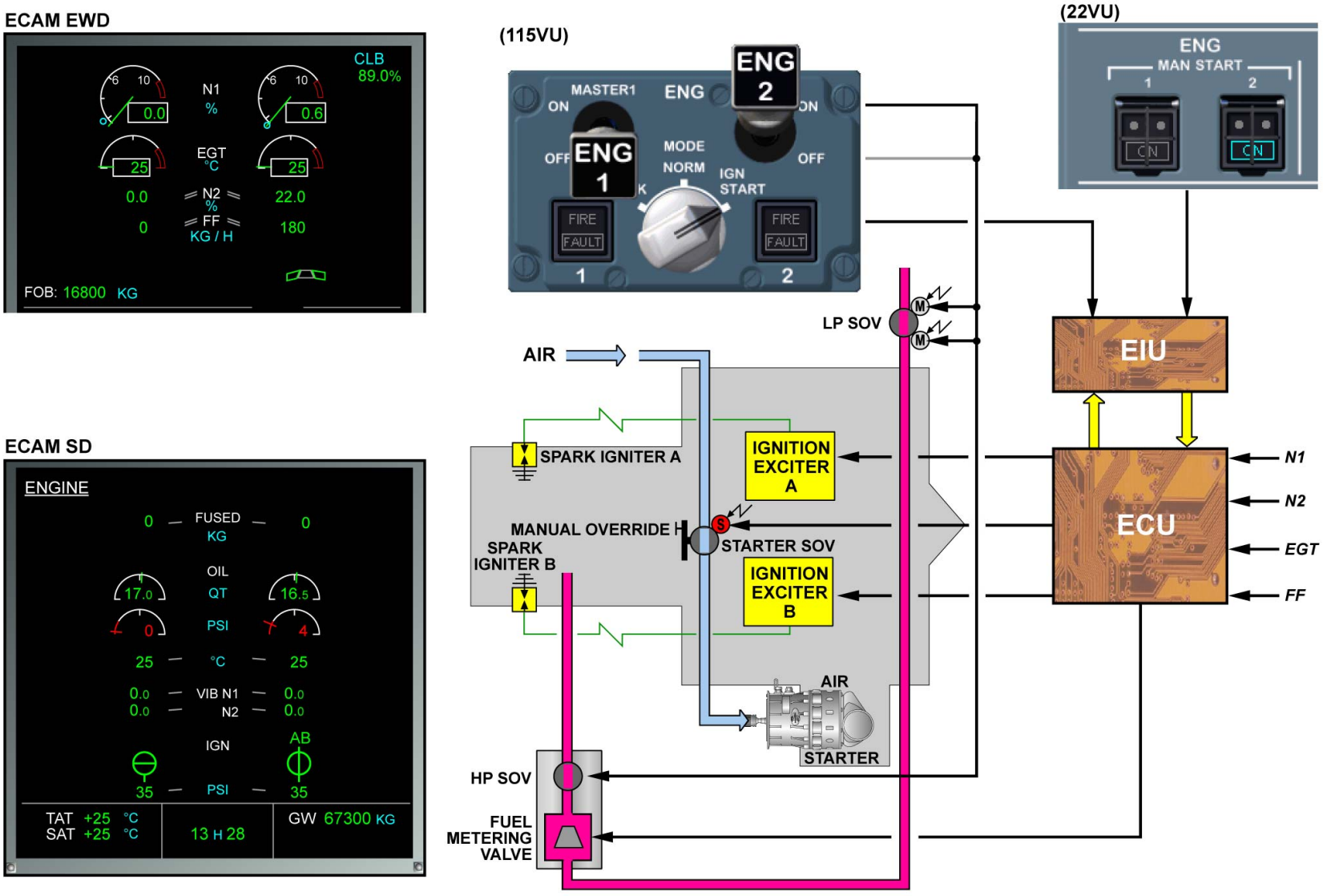
MANUAL START



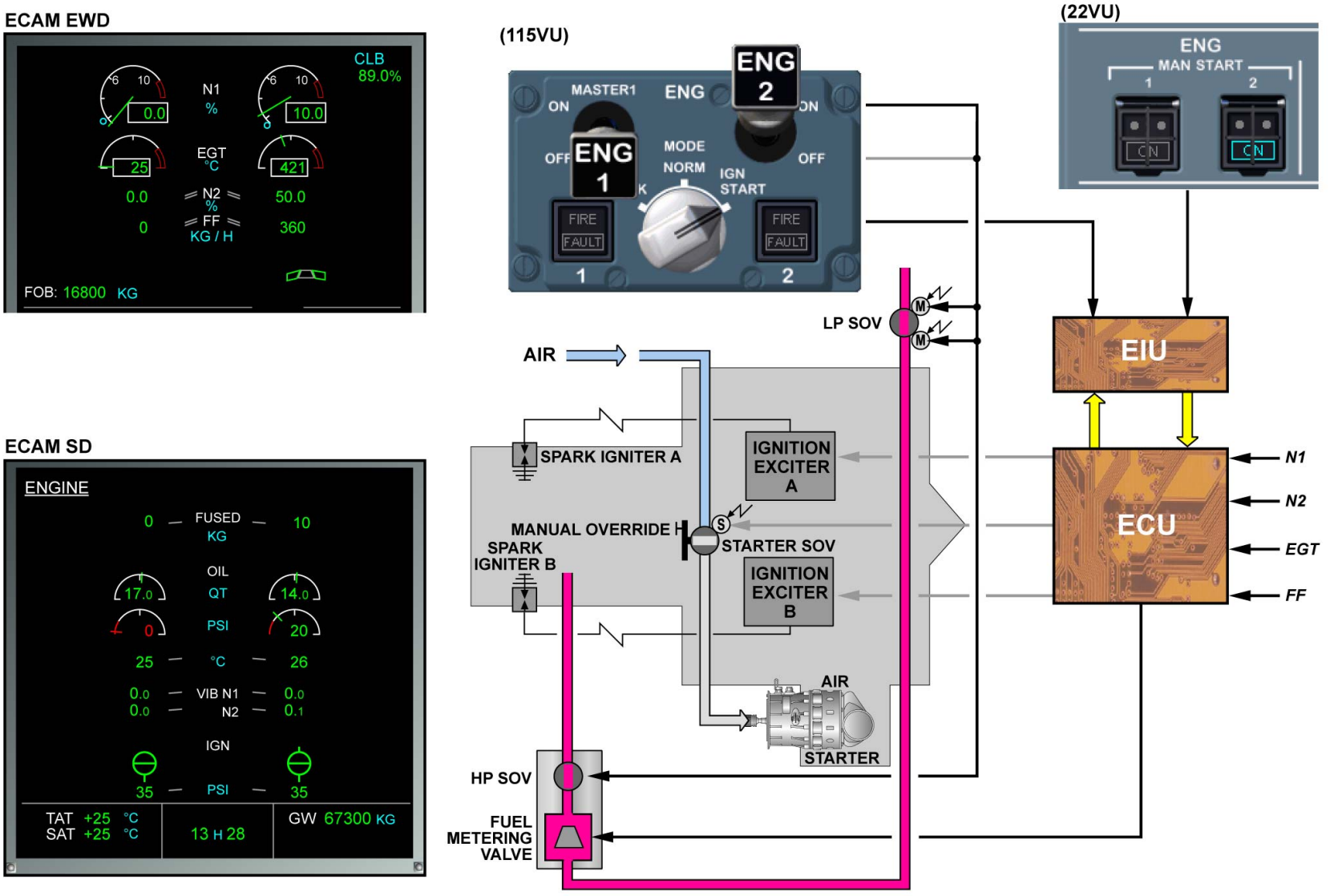
MANUAL START



MANUAL START



MANUAL START



MANUAL START

IGNITION & STARTING SYSTEM D/O (ME) (3)

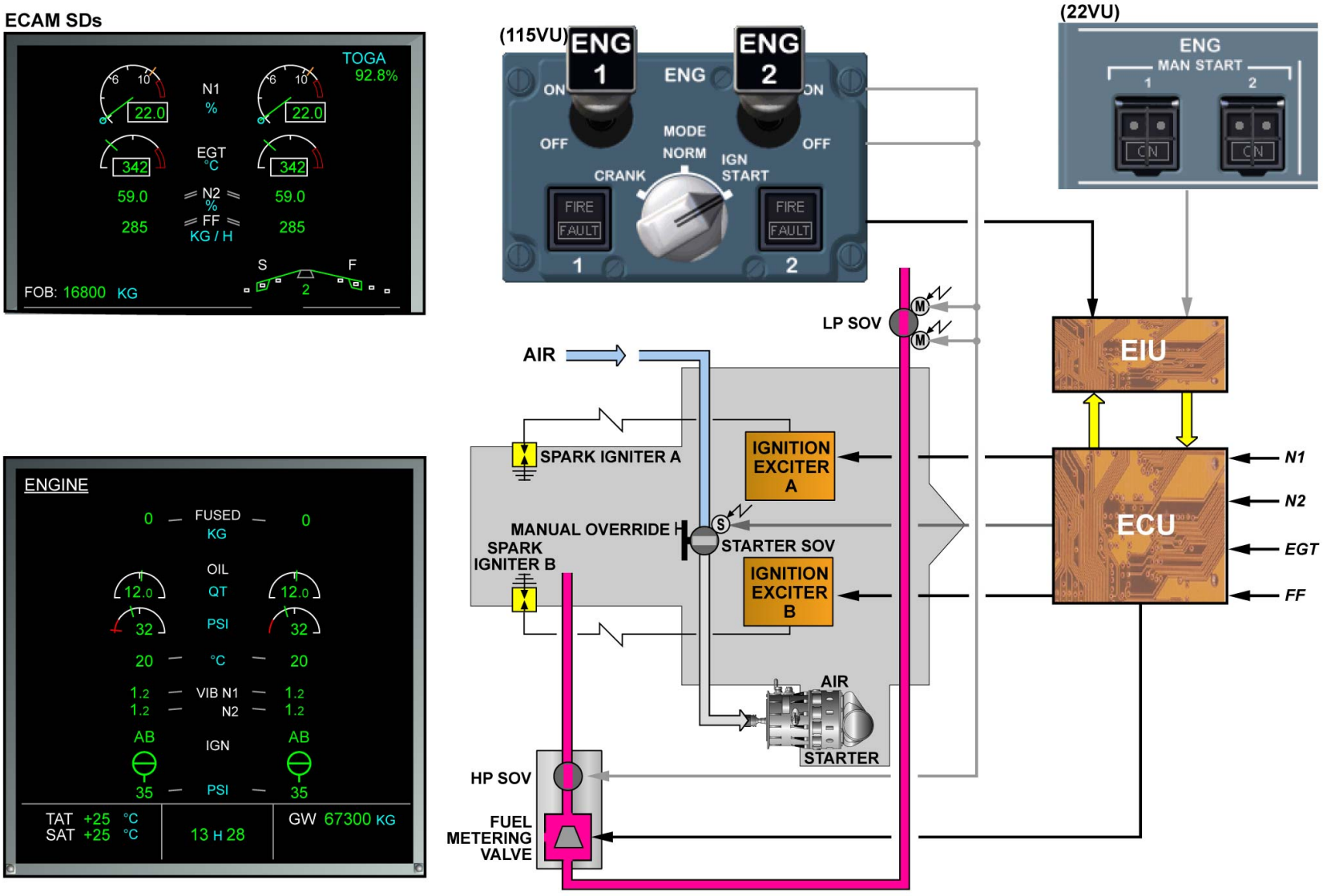
CONTINUOUS RELIGHT

Continuous relight.
The aircraft configuration in this case is the following:
- APU running and APU BLEED on,
- engine 2 running.

Continuous ignition is manually selected or automatically controlled by the FADEC.
If IGNition START is re-selected with an engine running, the corresponding ECU supplies the two igniters together, to provide a permanent ignition.
The automatic selection is provided by the FADEC when:
- Engine Interface Unit (EIU) failed,
- engine flame-out detected,
- ignition delay is sensed during start,
- in flight restart.

The continuous relight is cut off in MODE NORMal.

UG913131 - U7RT0EC - UM74D1CFM000001



CONTINUOUS RELIGHT

UG913131 - U7RT0EC - UM74D1CFM000001

IGNITION & STARTING SYSTEM D/O (ME) (3)

ENGINE CRANK

DRY CRANK

Engine CRANK modes:
- dry CRANK,
- wet CRANK.

The aircraft configuration in this case is the following:
- APU running and APU BLEED on,
- FADEC 1 and 2 powered,
- both engines shut down,
- C/B 1KC1(2) (ENGINE HP FUEL SOV) opened (dry crank only) to open the LP SOV. Fuel inlet pressure has to be positive (dry crank and wet crank).

When CRANK is selected on the ground, the ENGINE page appears automatically on the ECAM and the ECU initiates a motoring sequence after action on the MANual START P/B.

With CRANK selected, ignition is inhibited.

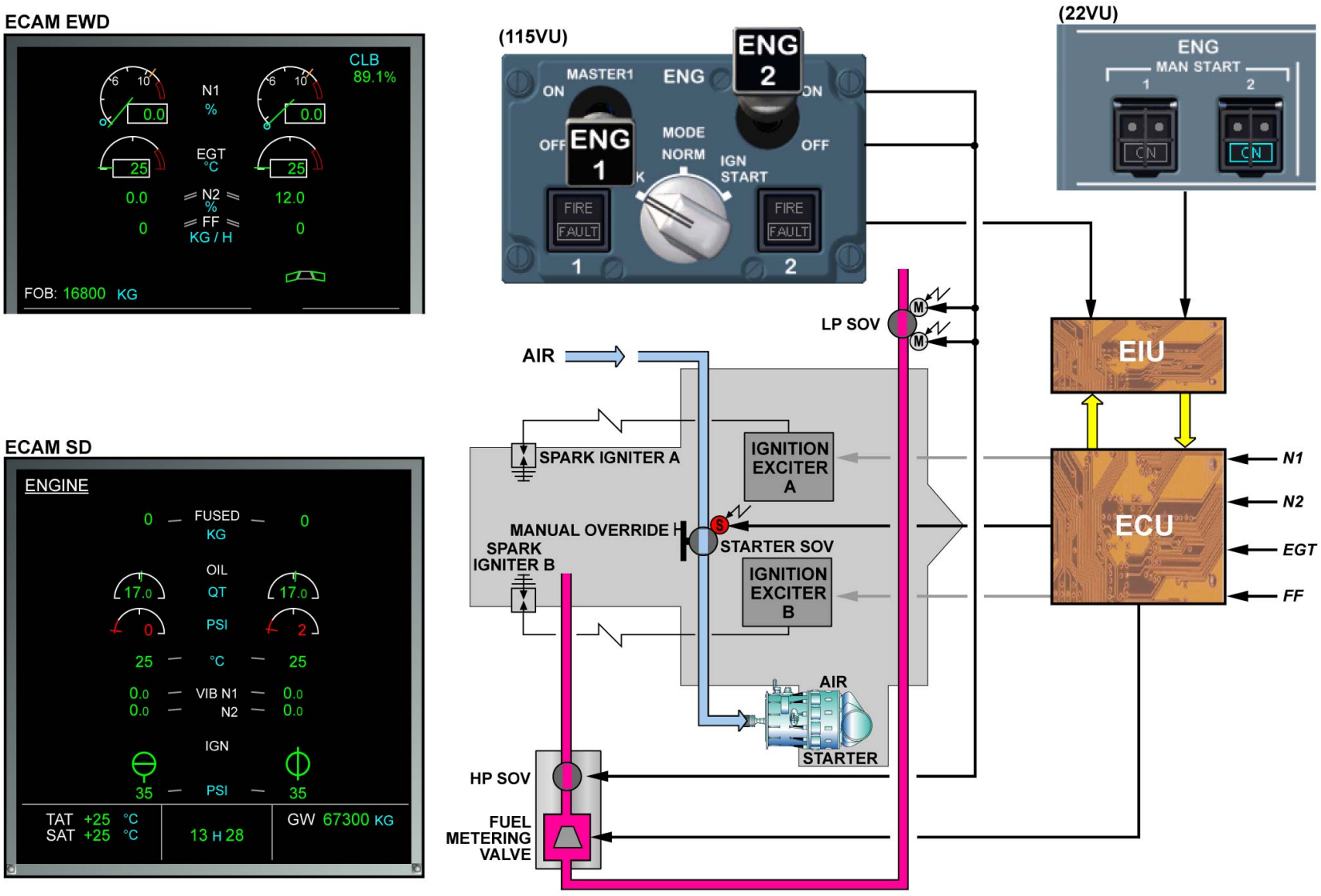
The action on the ENGine MANual START P/B opens the starter SOV.

During the crank sequence the starter limitations have to be observed. Make sure that you do not go over the limits.

An acceptable duty cycle can be performed with the following procedure:
- 2 minutes on,
- 20 seconds off,
- up to four times and then,
- 15 minutes off for cooling.

If the starter operation time is exceeded, a warning message is displayed on the ECAM.

UG913131 - U7RT0EC - UM74D1CFM000001



ENGINE CRANK - DRY CRANK

IGNITION & STARTING SYSTEM D/O (ME) (3)

ENGINE CRANK (continued)

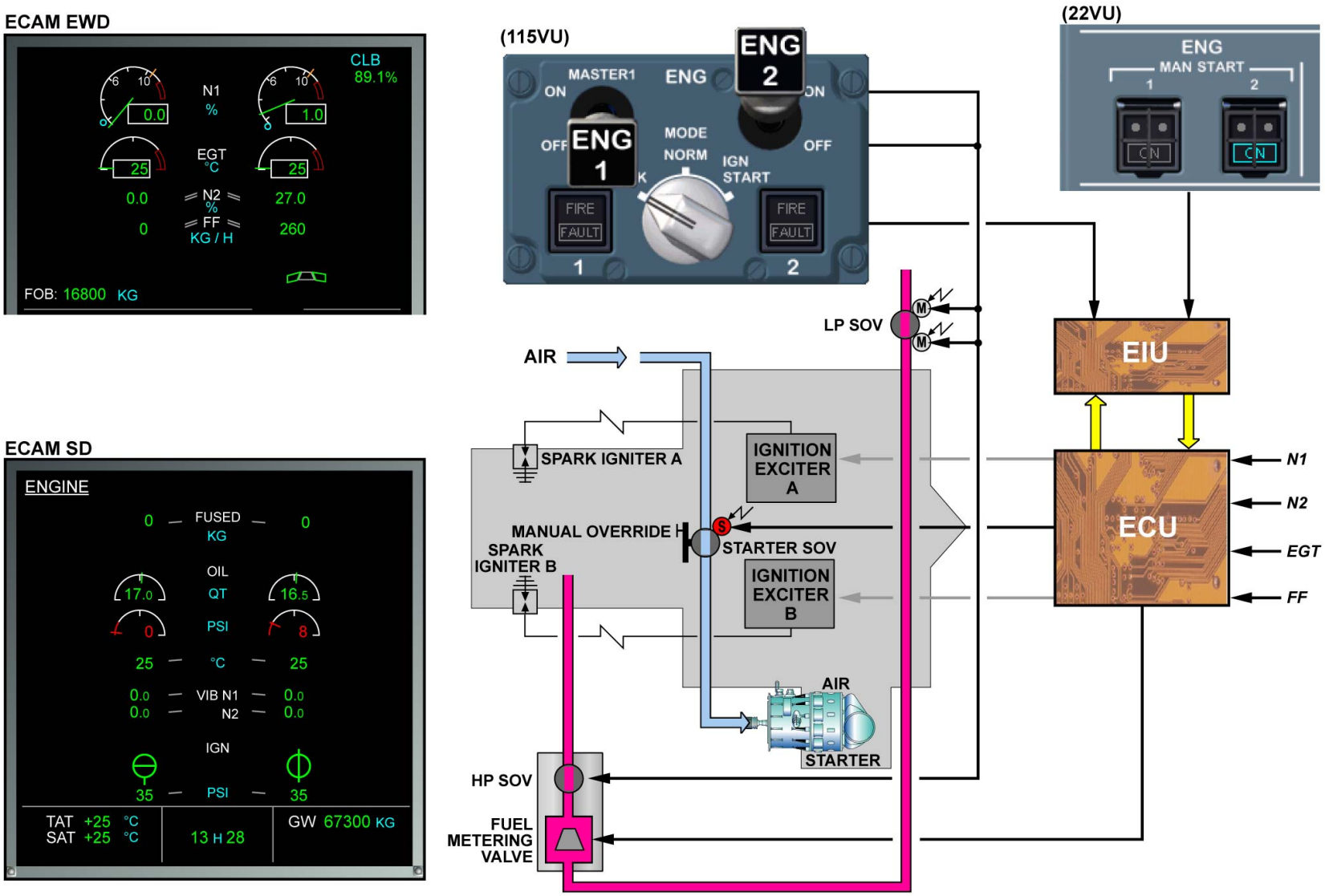
WET CRANK

When the MASTER control switch is set to the ON position, the LP and HP fuel SOV are opened.
For a wet crank, the MASTER control switch is normally set to ON between 15 and 20% of N2.

CAUTION: - DO NOT MOTOR THE ENGINE FOR MORE THAN 15 SECONDS WITH THE MASTER CONTROL SWITCH IN THE ON POSITION.

After a wet crank of 15 seconds maximum, when the MASTER control switch is set to the OFF position, the fuel is cut off and the starter SOV closes following the reset of the ECU.
After the reset of the ECU, the ECU will command the starter SOV to open when the N2 speed is less than 10%. The dry CRANK procedure is initiated.
Continue to dry crank the engine for 60 seconds (within the starter limitation of 2 minutes on), this will dry the fuel that can be in the combustor.
After 60 seconds, release the MANual START P/B switch to interrupt the crank sequence and set the selector back to MODE NORMal position.
When the MANual START P/B is released out, the starter SOV closes.
With the selector in the MODE NORM position and engines shut down, the DOOR/OXYgen page is displayed on the ECAM.

UG913131 - U7RT0EC - UM74D1CFM000001



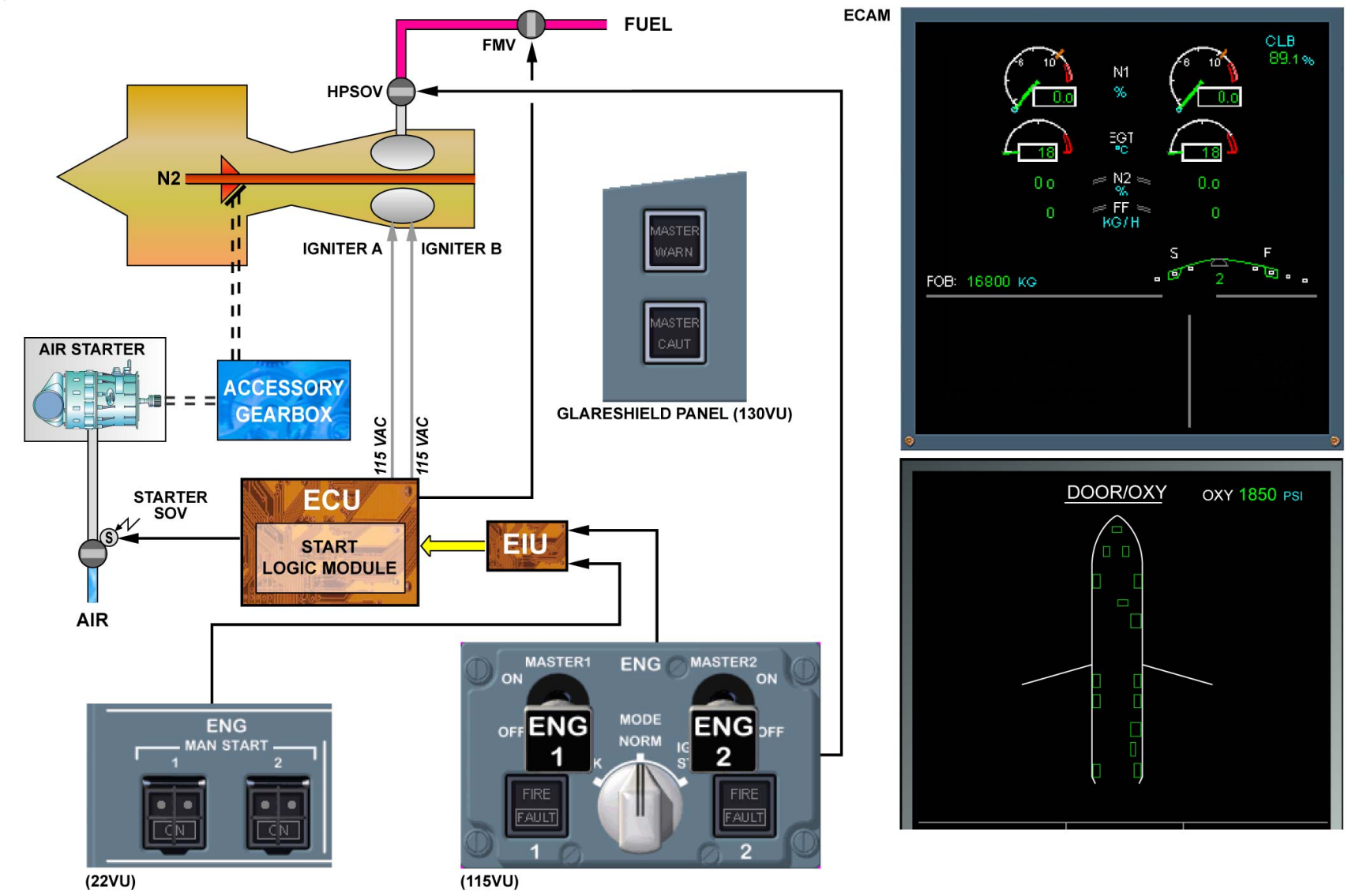
ENGINE CRANK - WET CRANK

START FAILURES (ME) (3)

GENERAL

The aircraft configuration for each fault is:
- APU bleed ON,
- Full Authority Digital Engine Control (FADEC) 1 and 2 powered,
- and residual Exhaust Gas Temperature (EGT) is Outside Ambient Temperature (OAT).

UG913131 - U7RT0EC - UM74D2CFM000001


FUEL
FMV
HPSOV
N2
IGNITER A
IGNITER B
AIR STARTER
ACCESSORY GEARBOX
115 VAC
115 VAC
STARTER SOV
ECU
START LOGIC MODULE
EIU
AIR
MASTER WARN
MASTER CAUT
GLARESHIELD PANEL (130VU)
ENG
MAN START
1
2
CN
CN
(22VU)
MASTER1
ENG
MASTER2
ON
ON
OFF
ENG 1
MODE
NORM
ENG 2
OFF
FIRE
FAULT
FIRE
FAULT
1
2
(115VU)
ECAM
CLB
89.1 %
N1
%
0.0
0.0
EGT
°C
18
18
N2
%
FF
KG/H
0.0
0.0
0
0
S
F
2
FOB: 16800 KG
DOOR/OXY
OXY 1850 PSI

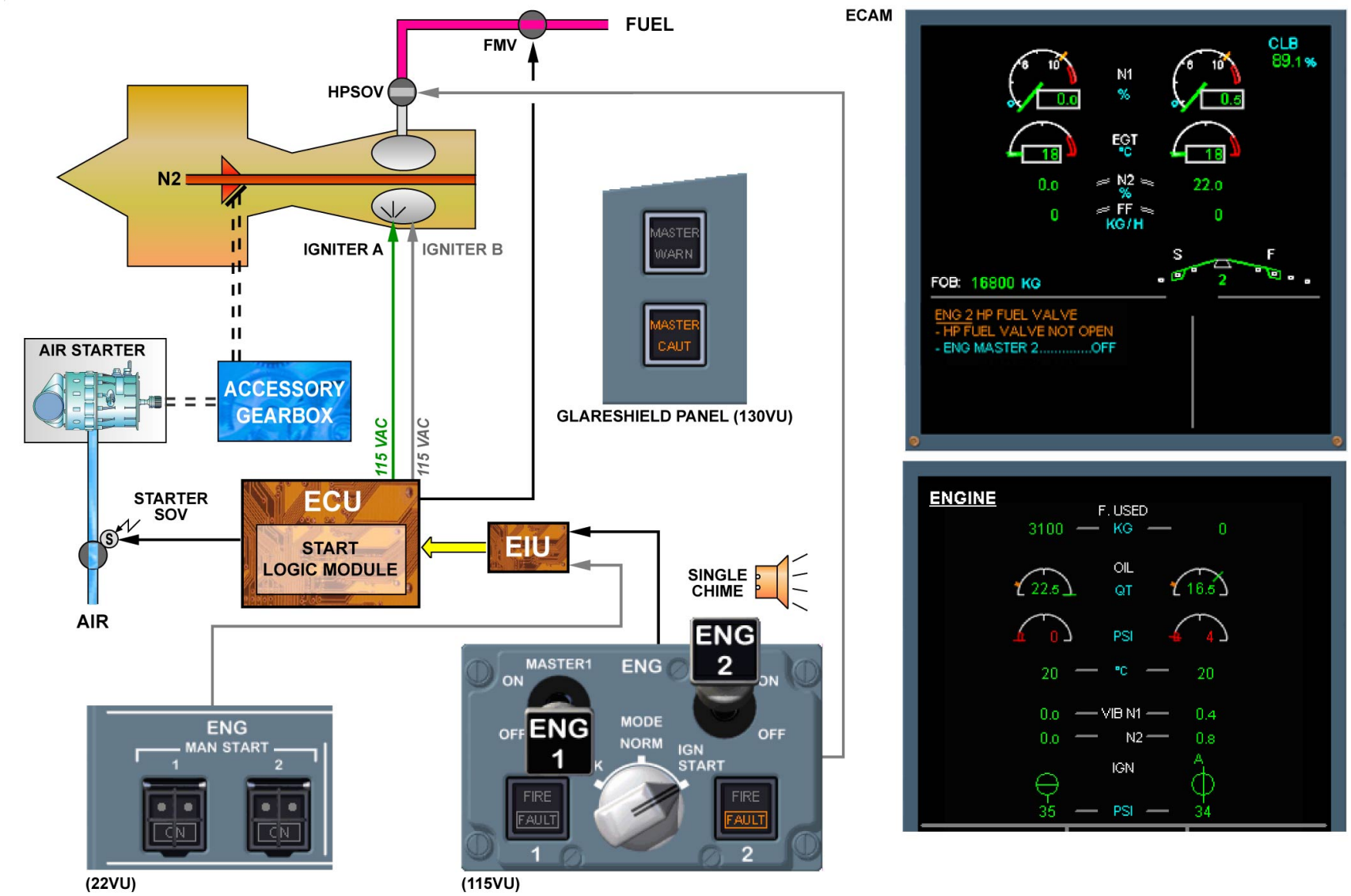
GENERAL

START FAILURES (ME) (3)

HIGH PRESSURE FUEL VALVE NOT OPEN FAULT IN AUTOMATIC MODE

If the High Pressure (HP) fuel valve does not open, an aural warning sounds, the MASTER CAUTion and the engine Fault lights come on and an ECAM message appears.
The FADEC has detected an HP fuel valve failure and the operator has to manually abort the sequence following the next steps:
- first set the MASTER control switch to off,
- and finally set the mode selector to the MODE NORMal position.

UG913131 - U7RT0EC - UM74D2CFM000001



HIGH PRESSURE FUEL VALVE NOT OPEN FAULT IN AUTOMATIC MODE

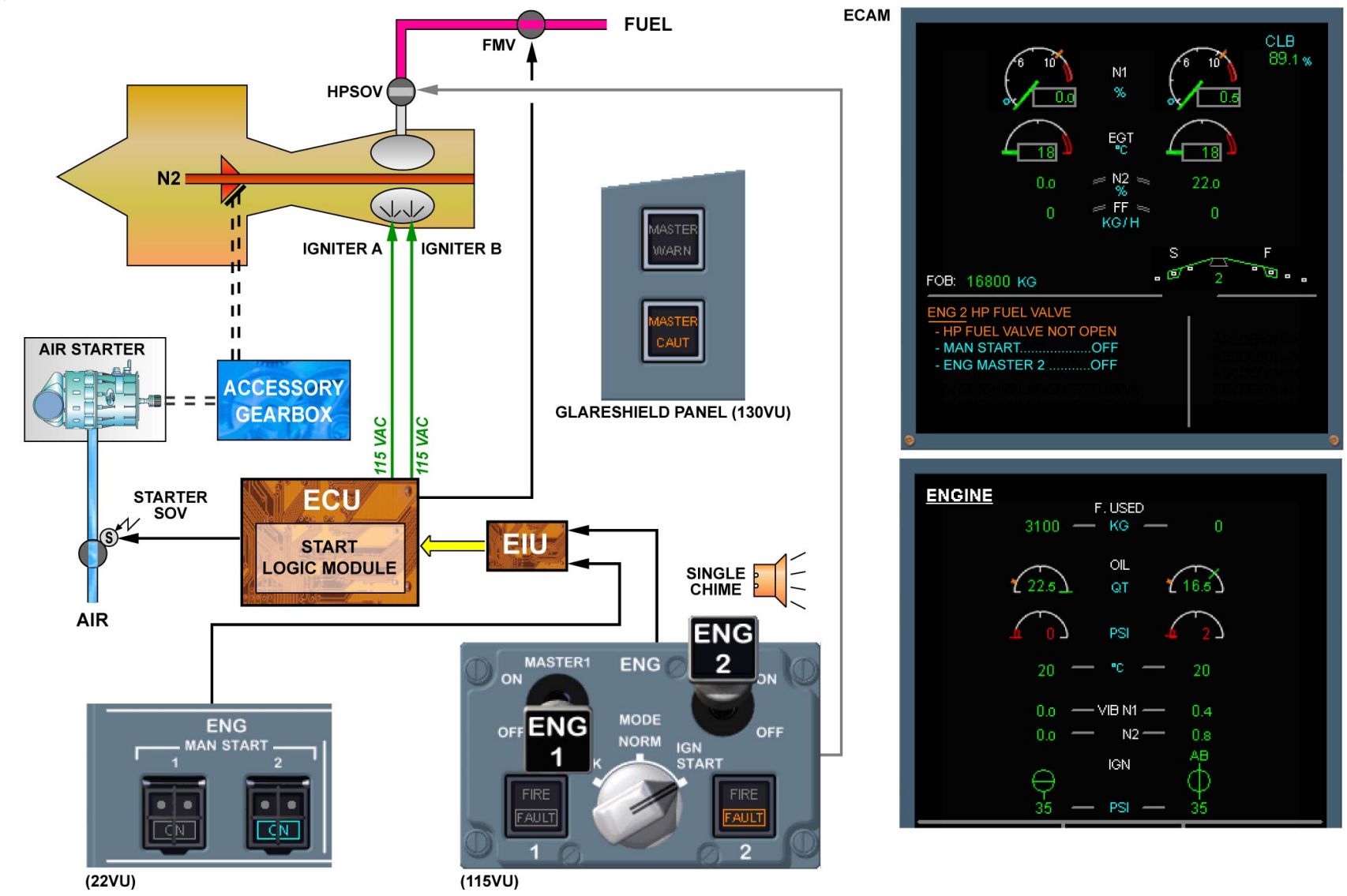
UG913131 - U7RT0EC - UM74D2CFM000001

START FAILURES (ME) (3)

HIGH PRESSURE FUEL VALVE NOT OPEN IN MANUAL MODE

If the HP fuel valve does not open, an aural warning sounds, the MASTER CAUTion and the engine FAULT lights come on and an ECAM message appears.
The FADEC has detected an HP fuel valve failure and the operator has to manually abort the sequence following the next steps:
- first release the MANual START P/B and then set the MASTER control switch to off,
- and finally set the mode selector to the MODE NORMal position.

UG913131 - U7RT0EC - UM74D2CFM000001



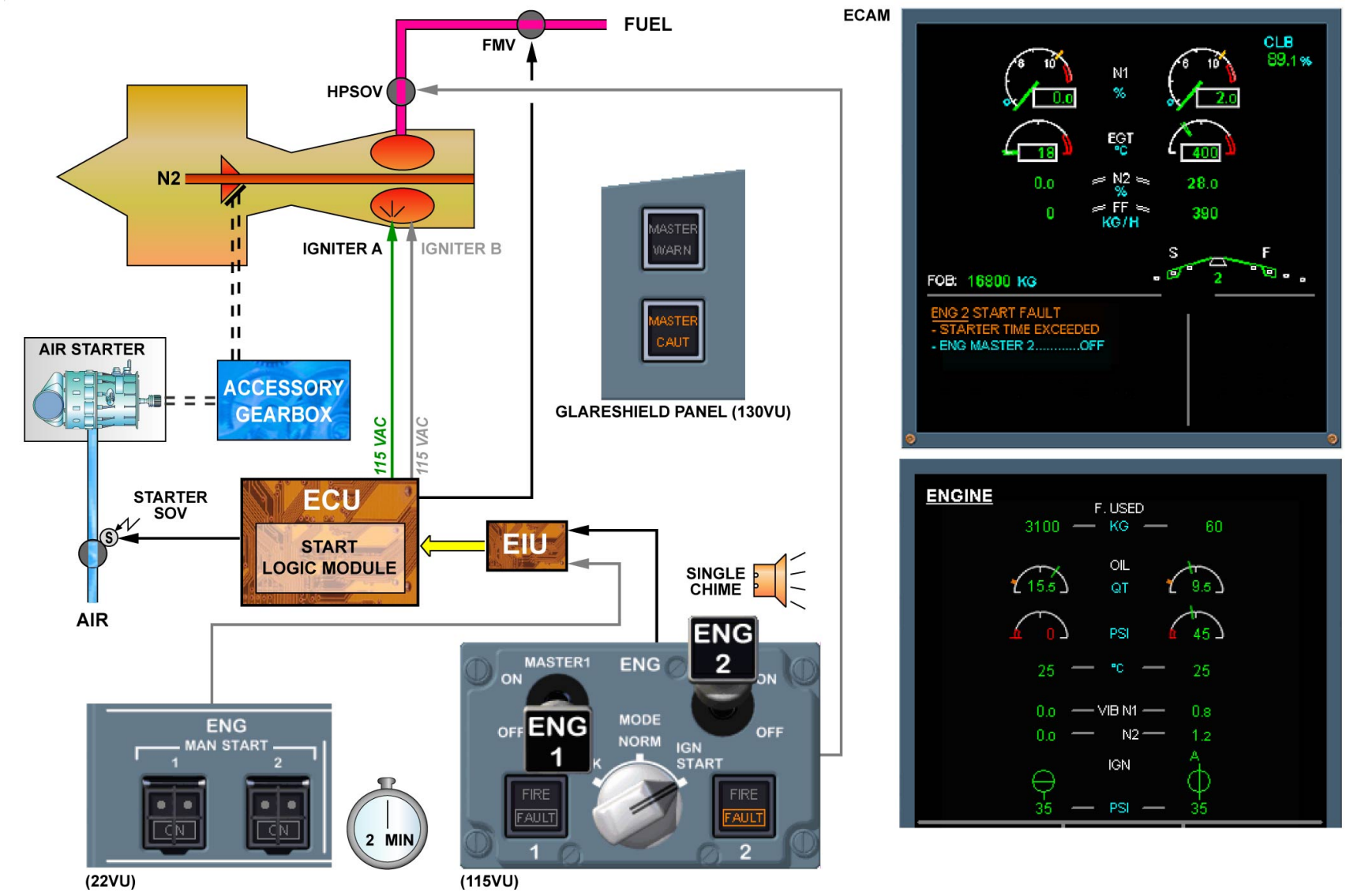
HIGH PRESSURE FUEL VALVE NOT OPEN IN MANUAL MODE

START FAILURES (ME) (3)

STARTER TIME EXCEEDED FAULT IN AUTOMATIC MODE

If the starter time is exceeded, an aural warning sounds, the MASTER CAUTion comes on and an ECAM message appears.
The FADEC has detected a starter time exceedence and the operator has to manually abort the sequence setting the MASTER control switch to off and finally setting the mode selector to the MODE NORMal position.
The maximum starter time cycle is 2 minutes.
The starter limitations are the following:
- 4 consecutive cycles, each of 2 minutes maximum,
- 20 seconds of non operation between cycles,
- after 4 cycles, wait 15 minutes before attempting a new start,
- and no running engagement of the starter when N2 is above 20%.

UG913131 - U7RT0EC - UM74D2CFM000001



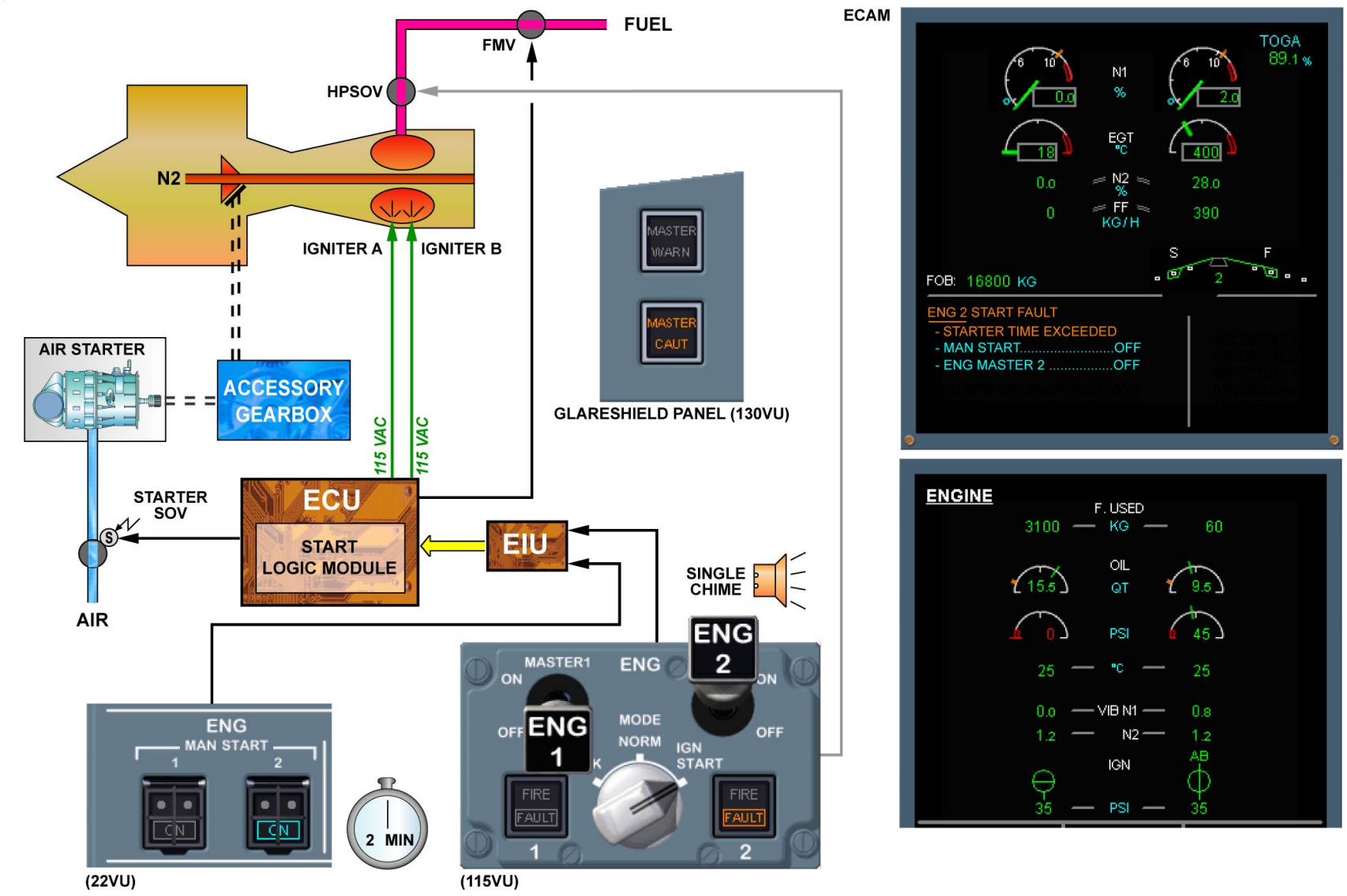
STARTER TIME EXCEEDED FAULT IN AUTOMATIC MODE

START FAILURES (ME) (3)

STARTER TIME EXCEEDED FAULT IN MANUAL MODE

If the starter time limit is exceeded, an aural warning sounds, the MASTER CAUTion comes on and an ECAM message appears.
The FADEC has detected a starter time exceedence and does not abort the start so the operator has to manually abort the sequence.
The maximum starter time cycle is 2 minutes, the same as in automatic mode.

UG913131 - U7RT0EC - UM74D2CFM000001



STARTER TIME EXCEEDED FAULT IN MANUAL MODE

START FAILURES (ME) (3)

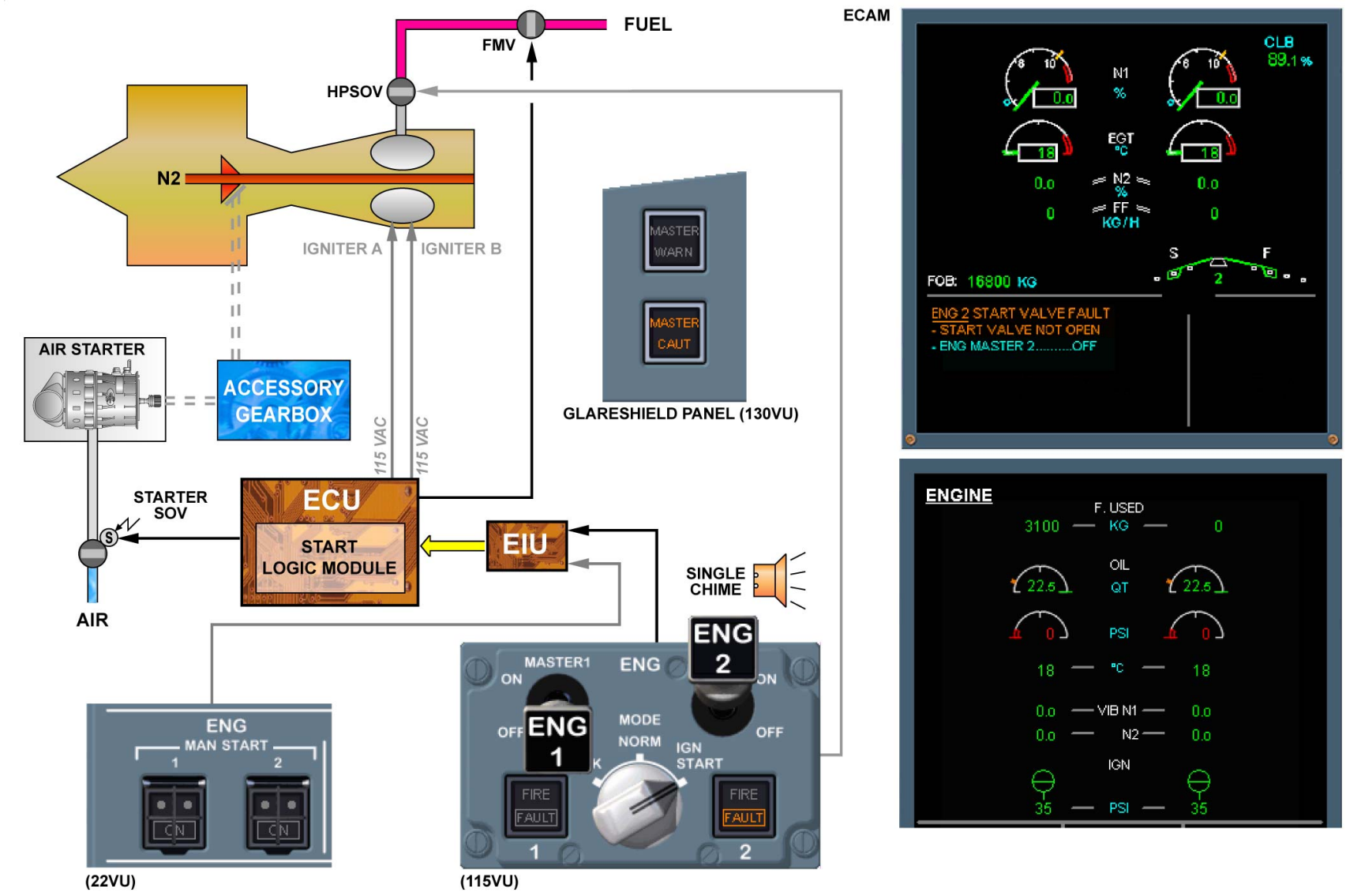
STARTER SHUT OFF VALVE NOT OPEN FAULT

If the starter Shut-Off Valve (SOV) does not open, an aural warning sounds, the MASTER CAUTion and engine FAULT lights come on and an ECAM message appears.
Depending on the pneumatic system configuration, the flight crew can check the available pneumatic sources on the EWD:
- "X BLEED .....ON" appears on the ECAM.

If APU available:
- "APU BLEED.....ON" appears on the ECAM.

If the starter SOV is failed in the closed position then another start with a starter manual operation by the ground crew can be done according to the next instructions.
Check on the ECAM engine page that pneumatic pressure is available at the starter SOV. Advise ground crew to prepare for a starter SOV manual operation.
Initiate a new automatic start by setting the Master Switch to OFF and then to ON again. Order the ground crew to open starter SOV.
When N2 reaches 50 %, the ground crew close the starter SOV.
Finally go on with the normal procedure.

UG913131 - U7RT0EC - UM74D2CFM000001



STARTER SHUT OFF VALVE NOT OPEN FAULT

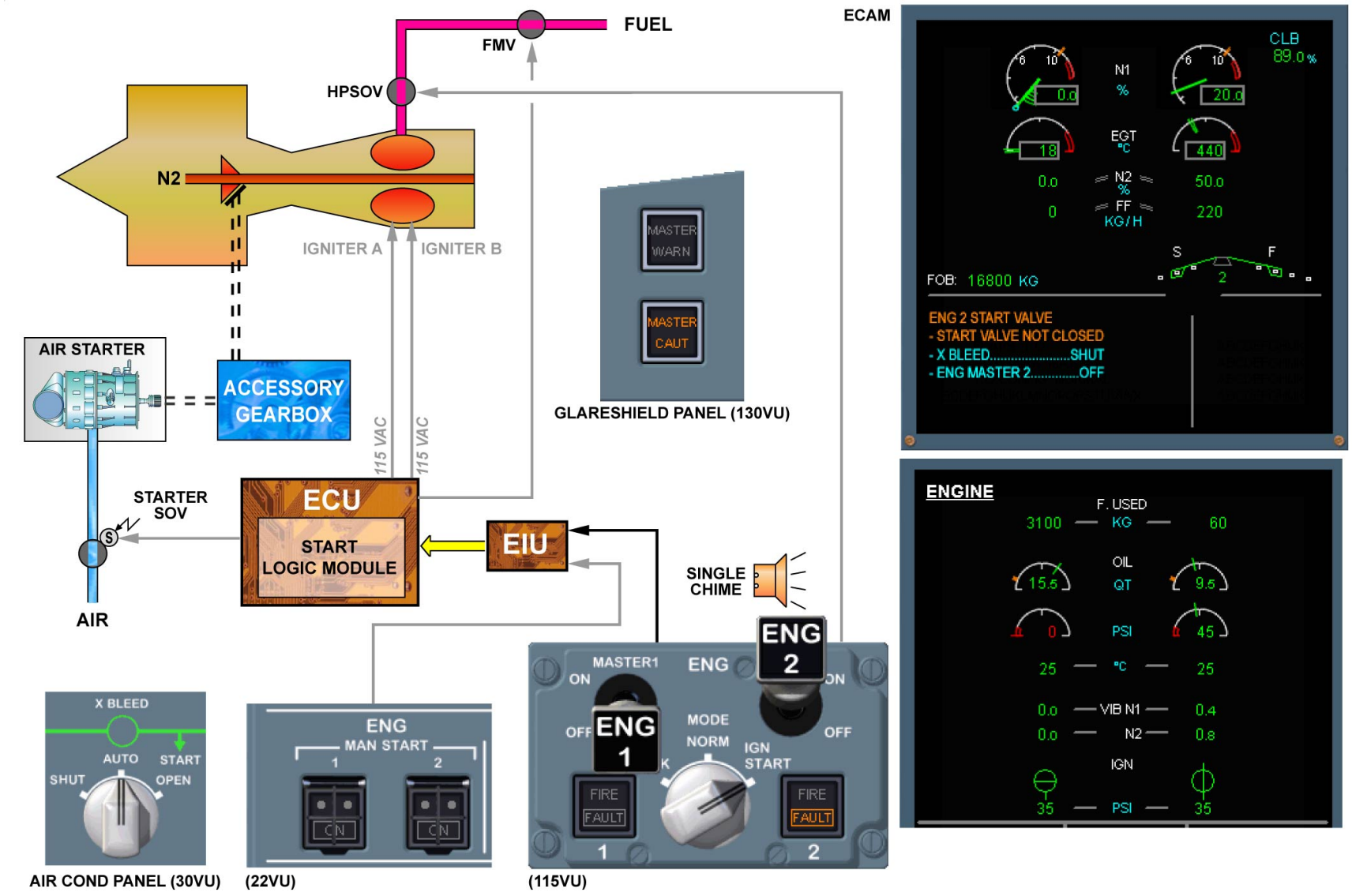
START FAILURES (ME) (3)

STARTER SHUT OFF VALVE NOT CLOSED FAULT

At 50 % of N2, the FADEC sends a signal to close the starter SOV.
If the starter SOV does not close, an aural warning sounds the MASTER CAUTion and the engine FAULT lights come on and an ECAM message appears.
The starter SOV not closed procedure will be performed following the next instructions:
Remove all bleed sources supplying the faulty starter SOV setting the X BLEED selector to shut.
- APU BLEED (if ENG 1 affected)...OFF,
- X BLEED.....SHUT,
- and ENG MASTER 1(2).....OFF appears on the ECAM.

No restart is allowed, a maintenance action is required.

UG913131 - U7RT0EC - UM74D2CFM000001



STARTER SHUT OFF VALVE NOT CLOSED FAULT

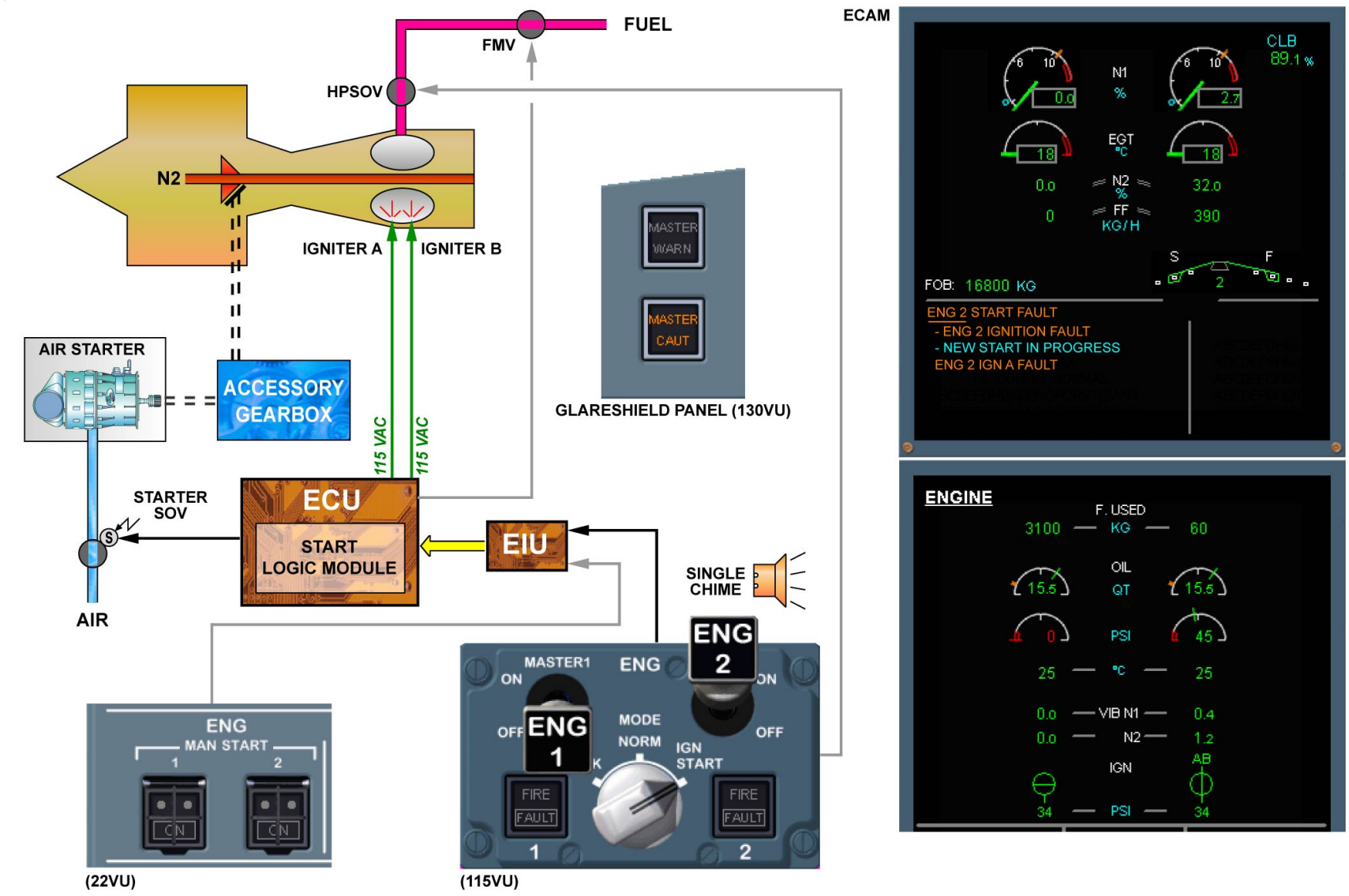
START FAILURES (ME) (3)

IGNITION FAULT IN AUTOMATIC MODE

In this failure case the ECU will automatically do 2 start attempts:
- 1 normal start,
- 1 additional attempt.

FIRST ATTEMPT

Select MODE selector to IGNition/START and ENGine MASTER control switch to ON.
The engine rotates, one ignitor is automatically turned ON at 16 % of N2 and fuel is automatically supplied at 22 % of N2.
If engine light-up is not obtained within 15 seconds, the FADEC automatically turns the ignition and the fuel OFF and dry cranks the engine for 30 seconds before initiating automatically a new start. An aural warning sounds, the MASTER CAUTion light comes on and an ECAM message appears.



IGNITION FAULT IN AUTOMATIC MODE - FIRST ATTEMPT

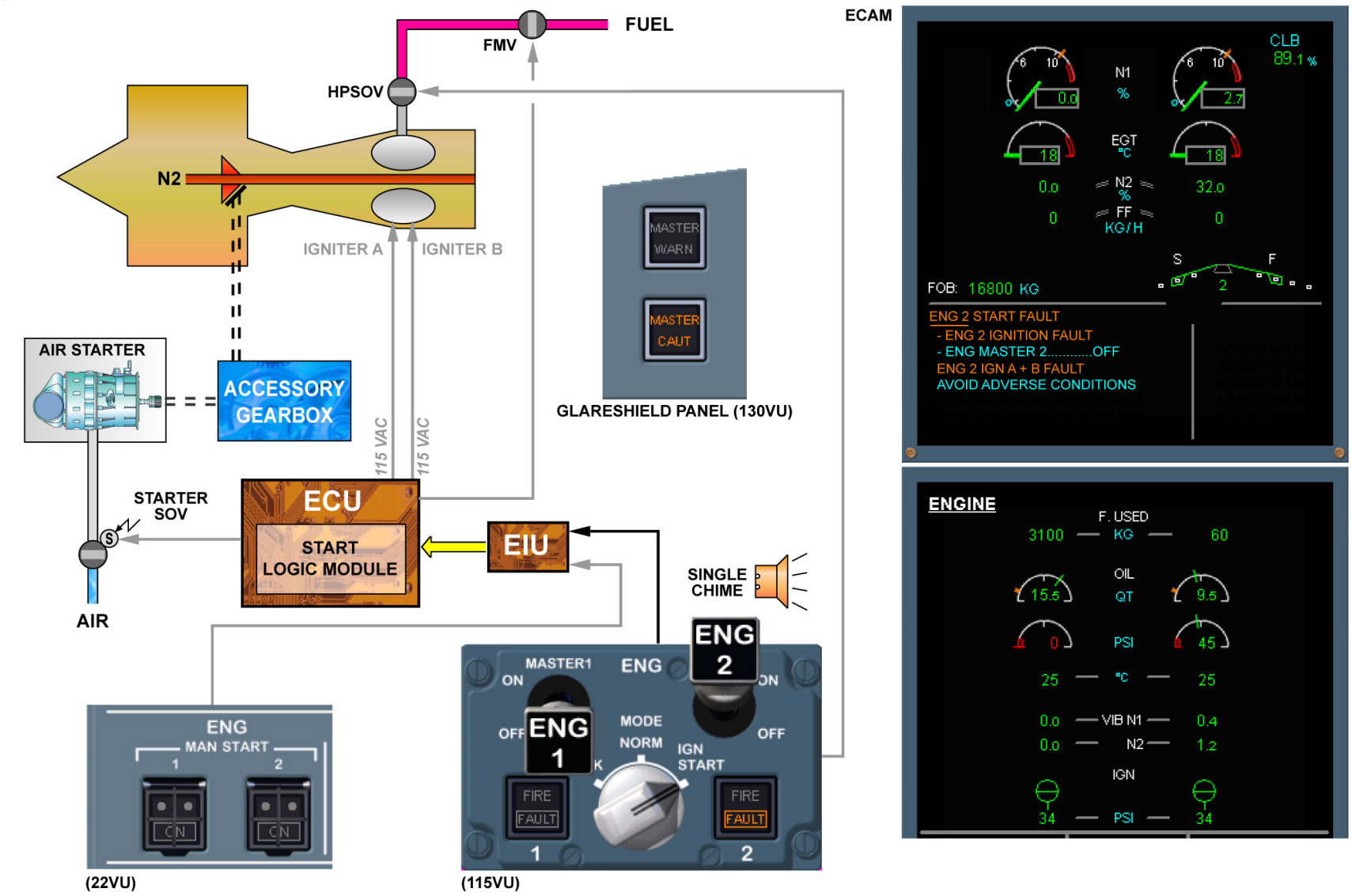
START FAILURES (ME) (3)

IGNITION FAULT IN AUTOMATIC MODE (continued)

SECOND ATTEMPT

At the 25th second of the dry crank period, both ignitors are re-energized.
Five seconds later, the fuel is supplied, (A B indications are displayed on the ECAM page).
If engine light-up is not obtained within 15 seconds, the FADEC automatically cuts ignition and fuel, dry cranks for 30 seconds, aborts the autostart, turns the engine fault light on and displays an ECAM message to select the ENGine MASTER to OFF.

UG913131 - U7RT0EC - UM74D2CFM000001



IGNITION FAULT IN AUTOMATIC MODE - SECOND ATTEMPT

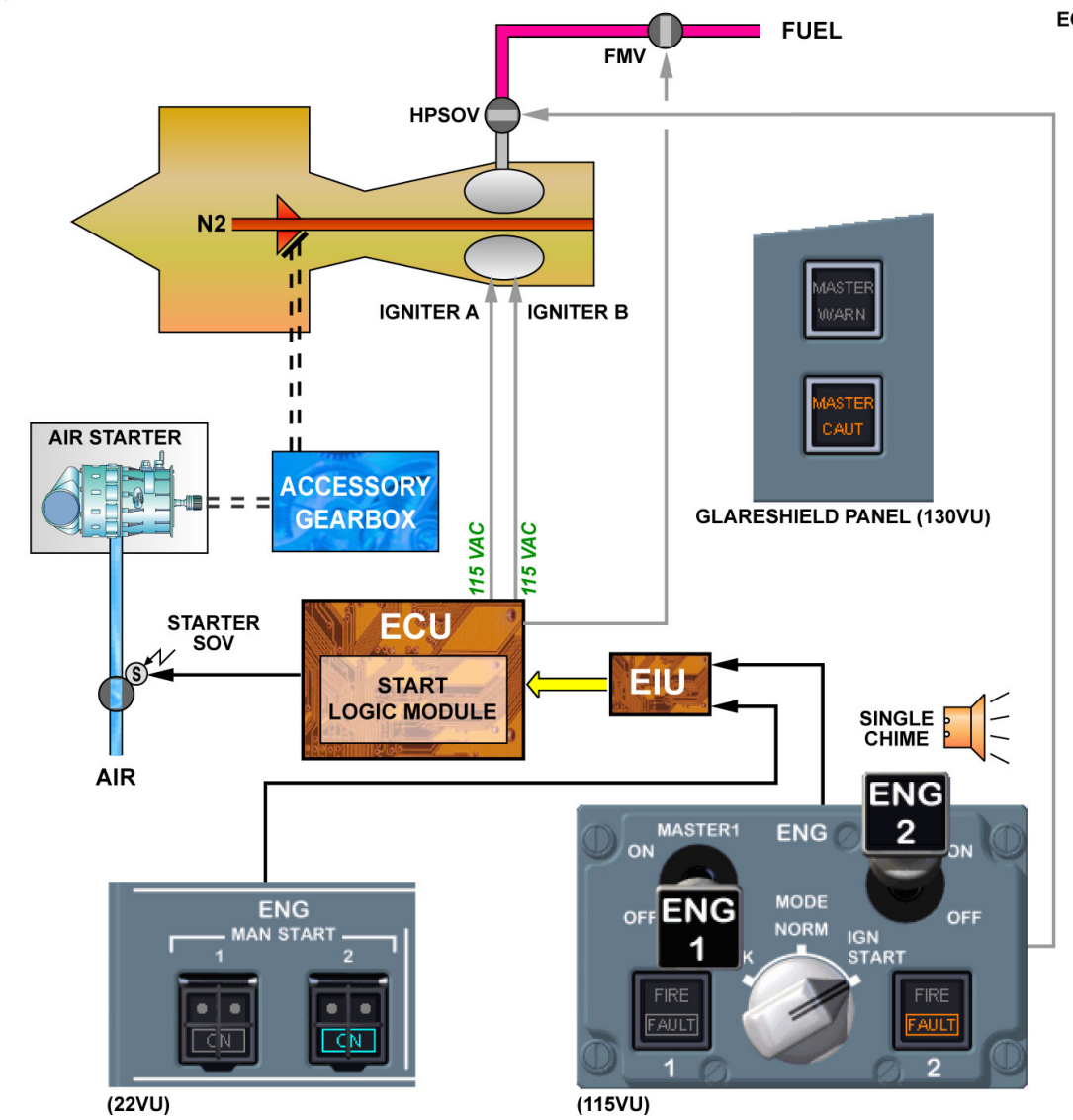
UG913131 - U7RT0EC - UM74D2CFM000001

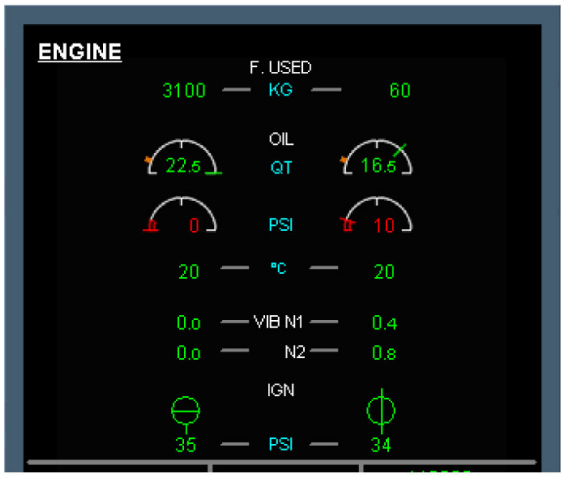
START FAILURES (ME) (3)

IGNITION FAULT IN MANUAL MODE

If an ignition fault occurs, an aural warning sounds, the MASTER CAUTion and the engine FAULT lights come on and an ECAM message appears.
In manual start, the FADEC does not abort the start, you must do the following actions necessary to shut down the engine:
- first release the MANual START P/B,
- next set the MASTER control switch to off,
- and finally set the mode selector to the MODE NORMal position.

UG913131 - U7RT0EC - UM74D2CFM000001





IGNITION FAULT IN MANUAL MODE

START FAILURES (ME) (3)

EXHAUST GAS TEMPERATURE OVERLIMIT OR STALL FAULT IN AUTOMATIC MODE

In case of detected stall or EGT overlimit, the FADEC monitoring and the flight crew actions are identical.
4 start attempts will be done, a normal start plus 3 additional attempts.

FIRST ATTEMPT

When a stall or an EGT overlimit is detected, an aural warning sounds, the MASTER CAUTion light comes on and an ECAM message appears.
The FADEC has detected a stall of the engine and will initiate a start abort, a crank and a restart sequence shutting off the fuel and ventilating the engine (crank time 7 seconds).

SECOND ATTEMPT

The FADEC reduces the fuel flow and attempts a second start. The fuel schedule reduction in the second start is 7 percent.
If the abnormality re-occurs a second time, the FADEC shuts off the fuel and ventilates the engine (crank time 7 seconds).

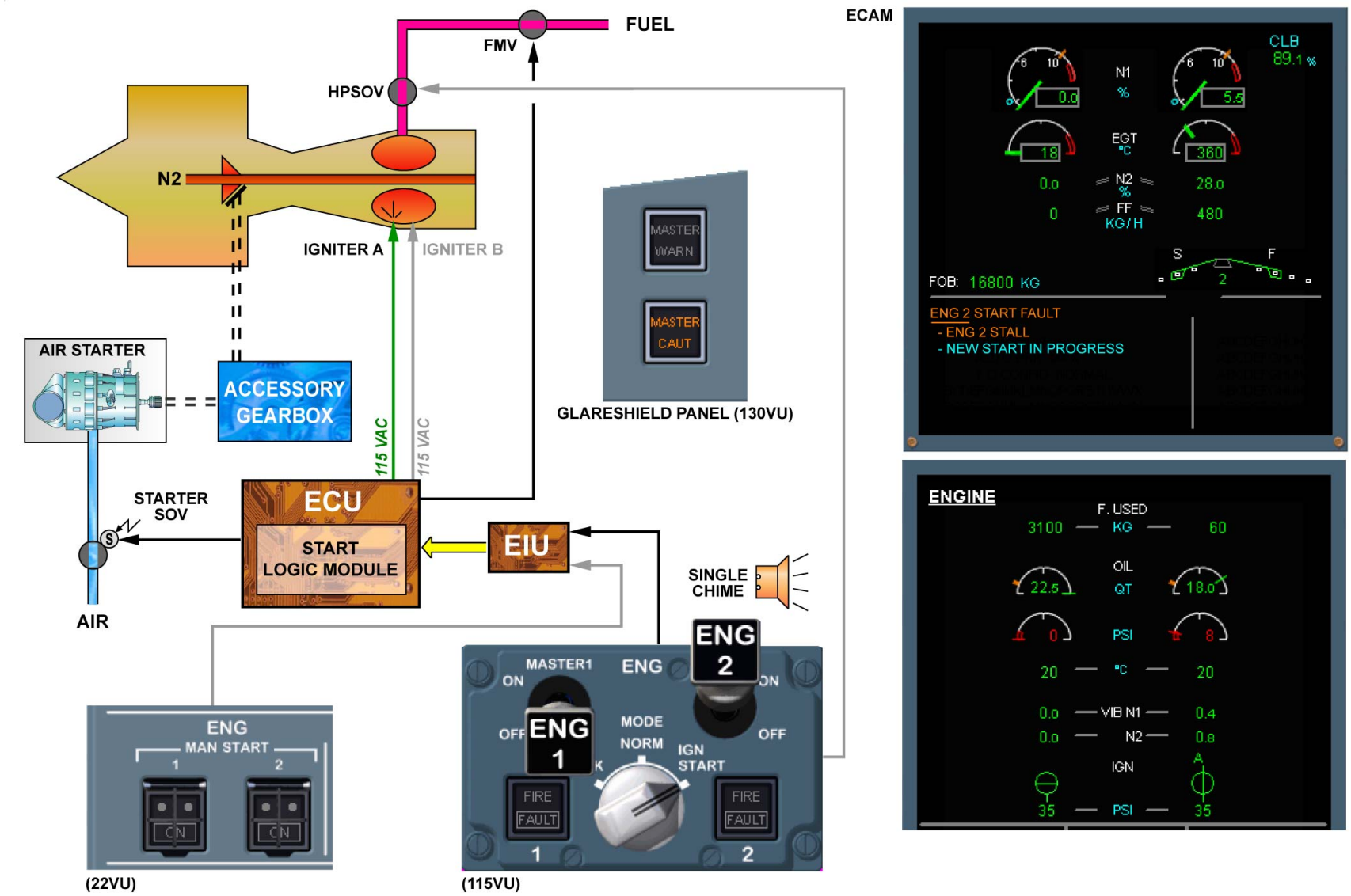
THIRD ATTEMPT

The FADEC reduces the fuel flow and attempts a third start. The fuel schedule reduction in the third start is 7 percent (a total of 14 percent).
If the abnormality occurs a third time, the FADEC shuts off the fuel and ventilates the engine (crank time 7 seconds).

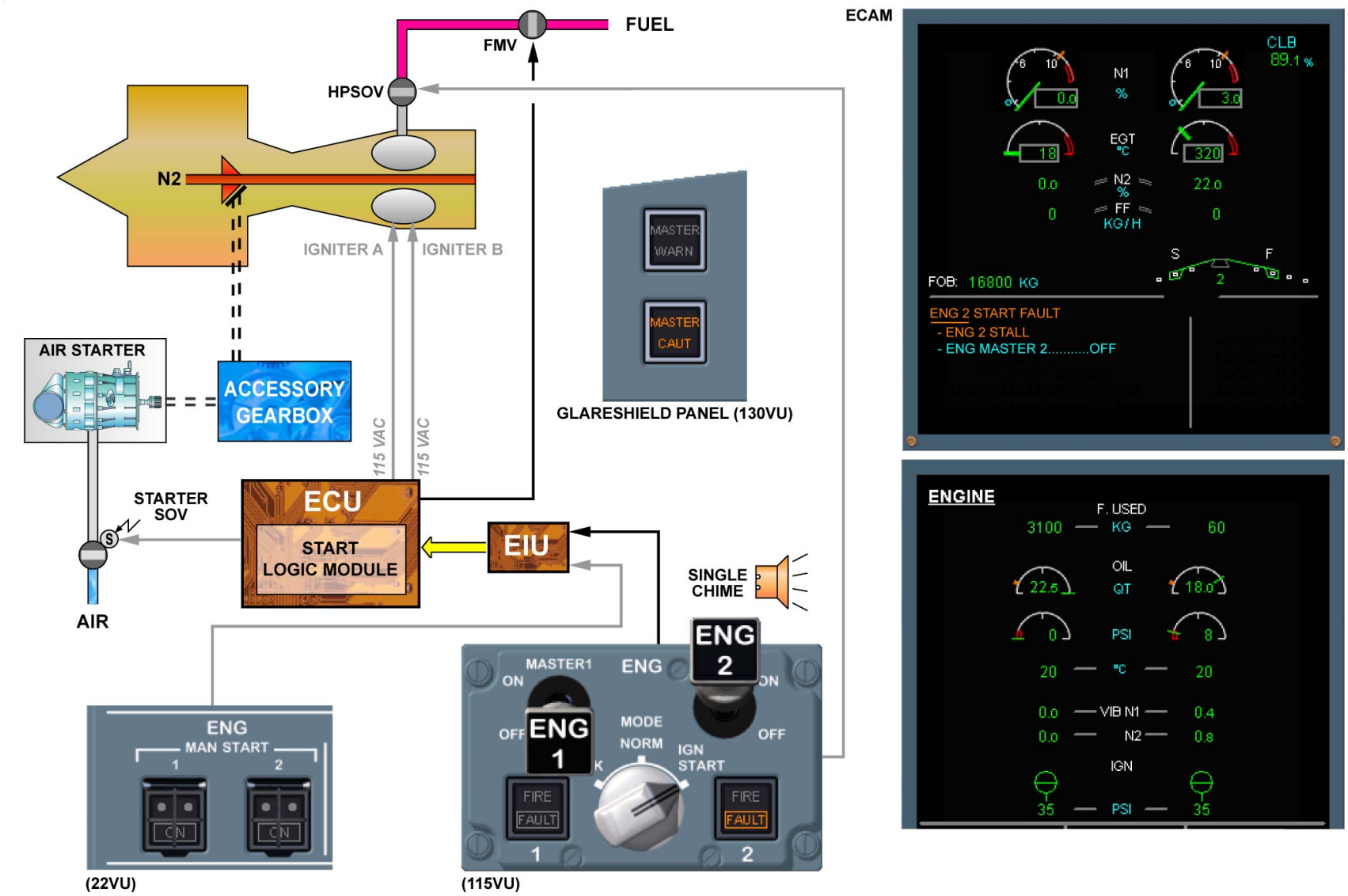
FOURTH ATTEMPT

After 7 seconds, the FADEC reduces the fuel flow again and attempts a fourth start. The fuel schedule reduction in the fourth start is 7 percent (a total of 21 percent).
If the abnormality occurs a fourth time, the FADEC aborts the start.

UG913131 - U7RT0EC - UM74D2CFM000001



EXHAUST GAS TEMPERATURE OVERLIMIT OR STALL FAULT IN AUTOMATIC MODE - FIRST ATTEMPT ... FOURTH ATTEMPT



EXHAUST GAS TEMPERATURE OVERLIMIT OR STALL FAULT IN AUTOMATIC MODE - FIRST ATTEMPT ... FOURTH ATTEMPT

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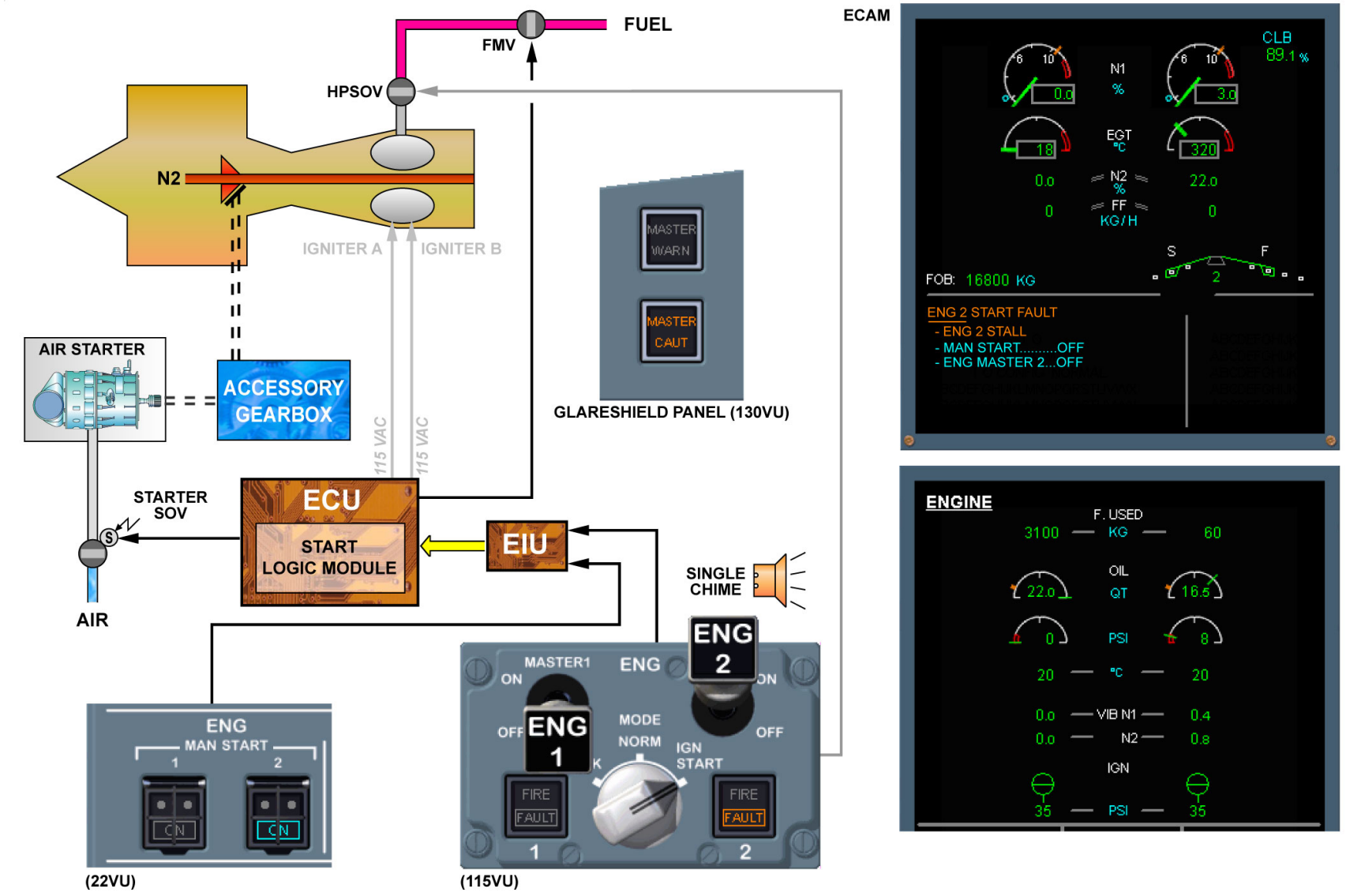
START FAILURES (ME) (3)

EXHAUST GAS TEMPERATURE OVERLIMIT OR STALL FAULT IN MANUAL MODE

When a stall or an EGT overlimit is detected, an aural warning sounds, the MASTER CAUTion and the engine FAULT lights come on and an ECAM message appears.
In the shown case, the FADEC has detected an engine stall. If no corrective action is taken by the crew, the FADEC will abort the start sequence following an EGT over limit detection.

UG913131 - U7RT0EC - UM74D2CFM000001



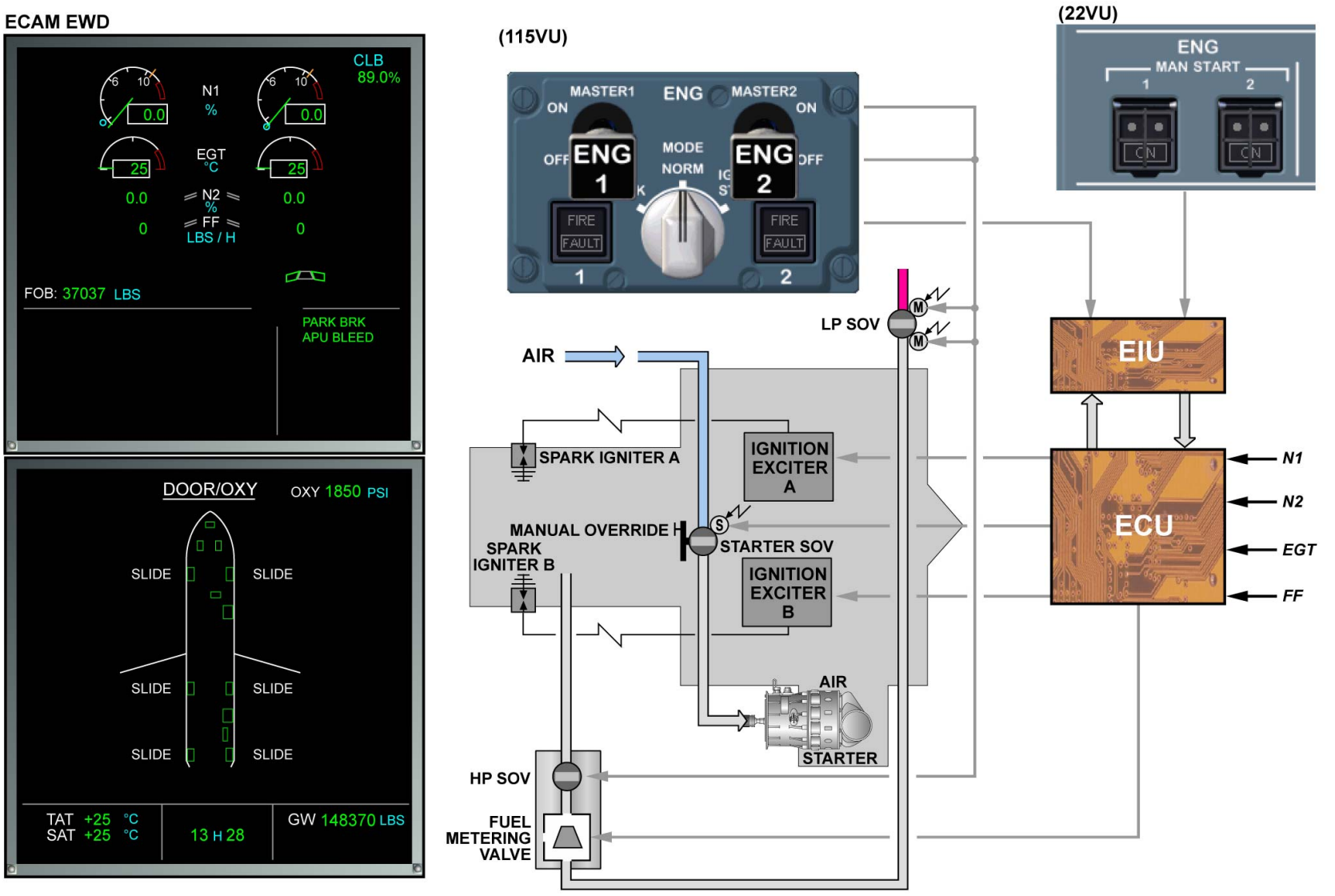
EXHAUST GAS TEMPERATURE OVERLIMIT OR STALL FAULT IN MANUAL MODE

IGNITION & STARTING SYSTEM D/O (US) (3)

GENERAL

The Electronic Control Unit (ECU) controls and monitors the start sequence either in automatic or manual mode.
In automatic mode the ECU is able, up to 50% N2, to abort the start sequence in case of an incident such as:
- starter Shut-Off Valve (SOV) failure,
- ignition failure,
- High Pressure (HP) fuel SOV failure,
- hot start,
- hung start or,
- engine stall.

The system consists of a starter SOV, an air starter, two ignition exciters, spark igniters (A and B) and two ignition leads.
The starter SOV is fitted with a manual override handle for manual operation in case of electrical SOV failure.
On the enhanced system, the same information is provided with a different display presentation.


ECAM EWD
CLB
89.0%
N1
%
0.0
0.0
EGT
°C
25
25
0.0
0.0
N2
%
FF
LBS / H
0
0
FOB: 37037 LBS
PARK BRK
APU BLEED
DOOR/OXY
OXY 1850 PSI
SLIDE
SLIDE
SLIDE
SLIDE
SLIDE
SLIDE
TAT +25 °C
SAT +25 °C
13 H 28
GW 148370 LBS
(115VU)
MASTER1
ENG
MASTER2
ON
ON
OFF
ENG 1
MODE
NORM
ENG 2
OFF
FIRE
FAULT
FIRE
FAULT
1
2
(22VU)
ENG
MAN START
1
2
CN
CN
LP SOV
AIR
EIU
SPARK IGNITER A
IGNITION EXCITER A
MANUAL OVERRIDE
SPARK IGNITER B
STARTER SOV
IGNITION EXCITER B
ECU
N1
N2
EGT
FF
AIR
STARTER
HP SOV
FUEL METERING VALVE

GENERAL

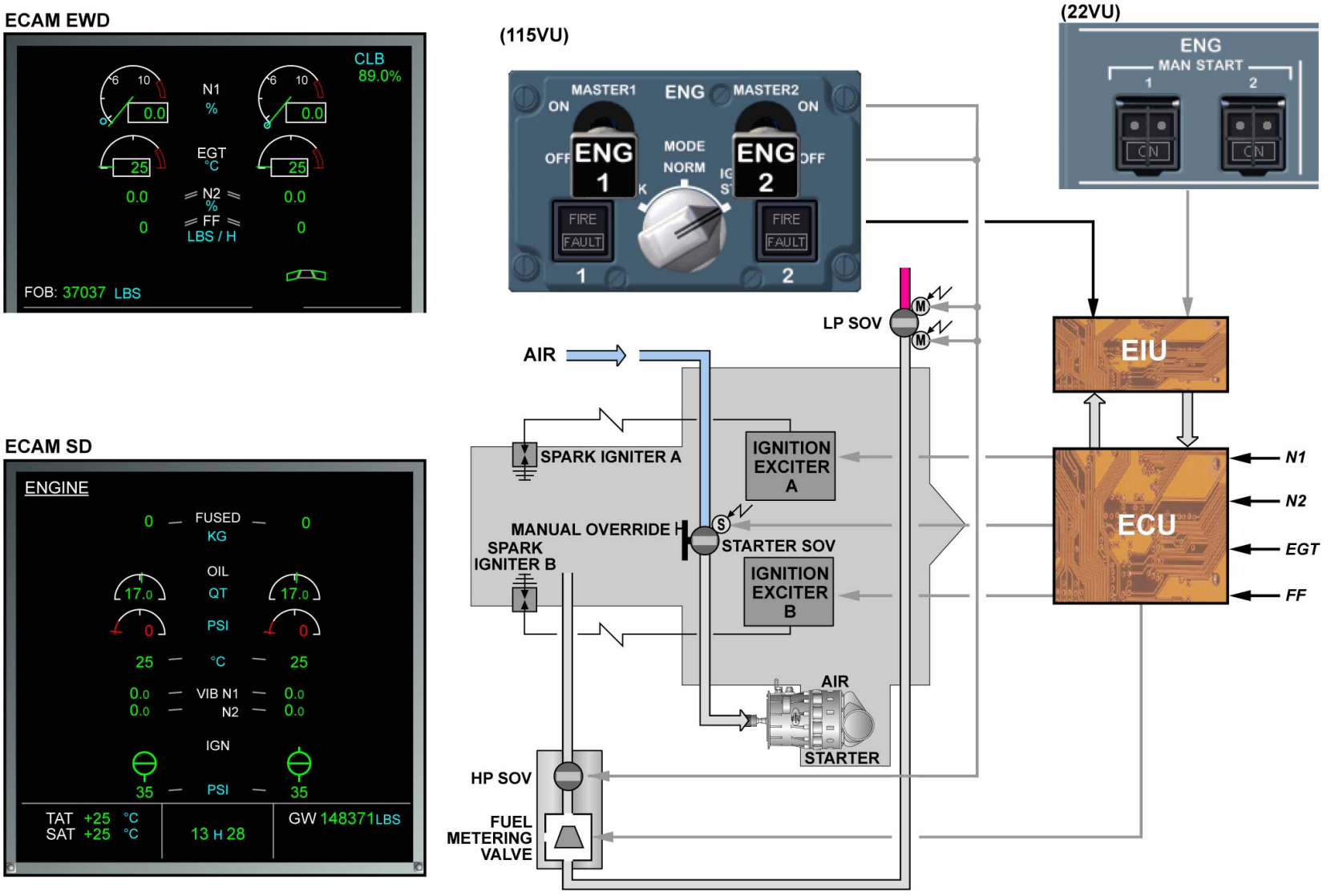
IGNITION & STARTING SYSTEM D/O (US) (3)

AUTOMATIC START

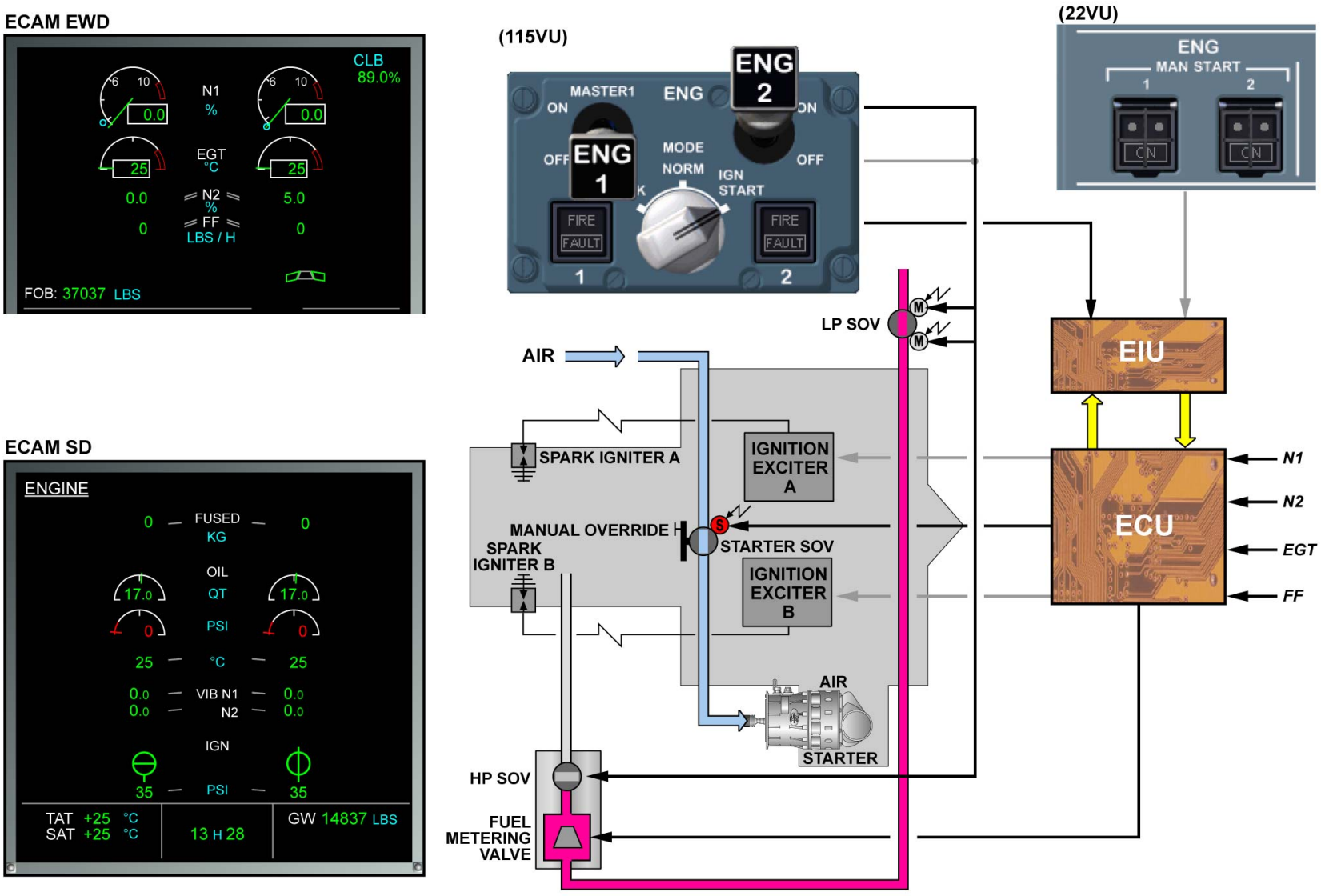
Start sequence in automatic mode.
The aircraft configuration in this case is the following:
- APU running and APU BLEED on,
- Full Authority Digital Engine Control (FADEC) 1 and 2 powered.

When IGNition START is selected the ENGINE page is called automatically. During engine start, the ENGINE page includes IGN indication, starter SOV position and bleed pressure.
During this time the pack valves are automatically closed. If, after 30 seconds, the ENGine MASTER control switch is not switched to ON position, the pack valves will re-open.
As soon as the ENGine MASTER control switch is set to ON position, the Low Pressure (LP) fuel SOV opens and the ECU opens the starter SOV. The position of this valve is confirmed on the ECAM and the N2 begins to increase.
When N2 reaches 16% the ECU provides ignition. The selection of the spark igniter is a function of the ECU and at each start the igniter selection will be changed.
At 16% of N2, on the ENGINE page, the corresponding spark igniter system (A or B) chosen by the ECU is displayed.
When N2 reaches 22% the ECU controls, through the Fuel Metering Valve (FMV), HP fuel SOV opening. At this percentage of N2, fuel flow begins.
The ECU monitors the Exhaust Gas Temperature (EGT) and N2 according to their schedules to provide the correct fuel flow. The maximum EGT during start sequence is 725º C.
In case of malfunction the ECU automatically shuts down the engine and performs a dry motoring sequence.
Up to 50% N2, the automatic fuel flow regulation is performed. At 50% N2, the ECU closes the starter SOV and cuts off the ignition.
The pack valves re-open if another engine is not started within 30 seconds.
Engine 2 is now stabilized at minimum idle.
To start the second engine, you set the MASTER control switch 1 to ON keeping the selector in the IGNition START position.
To complete this start sequence the selector is set back to MODE NORMal position. With the selector in this position and at least one engine running, the WHEEL page appears instead of the ENGINE page.
If IGNition START is re-selected, continuous ignition is initiated on the running engines.
At any time, if the MASTER lever is set to OFF, the start sequence or the engine operation is stopped because the MASTER control switch directly energizes the HP fuel SOV solenoid. With the MASTER control switch at OFF, the LP and HP SOVs are closed.
With both engines shut down, the DOOR/OXYgen page is displayed.

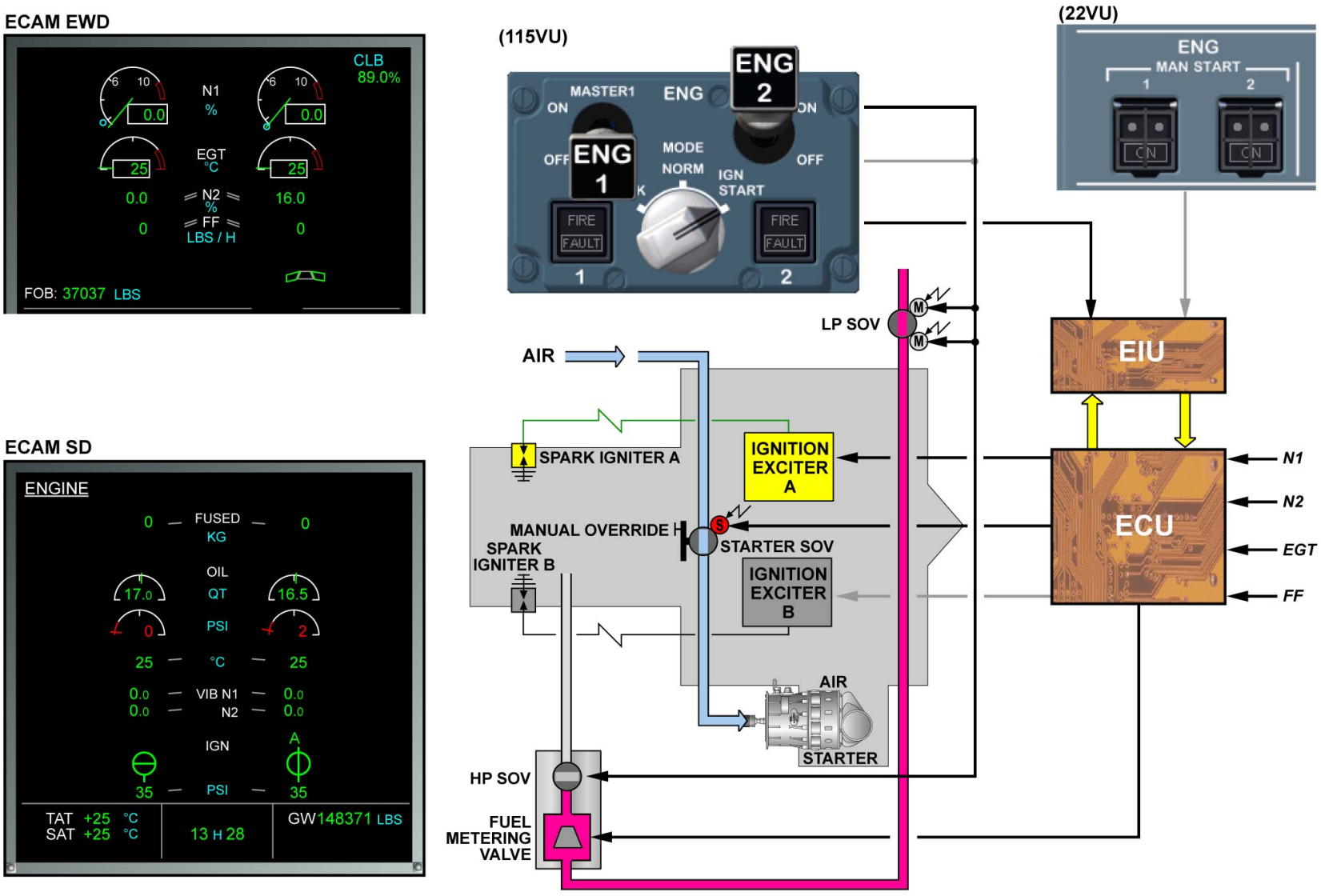
UG913131 - U7RT0EC - UM74D1CFM000002



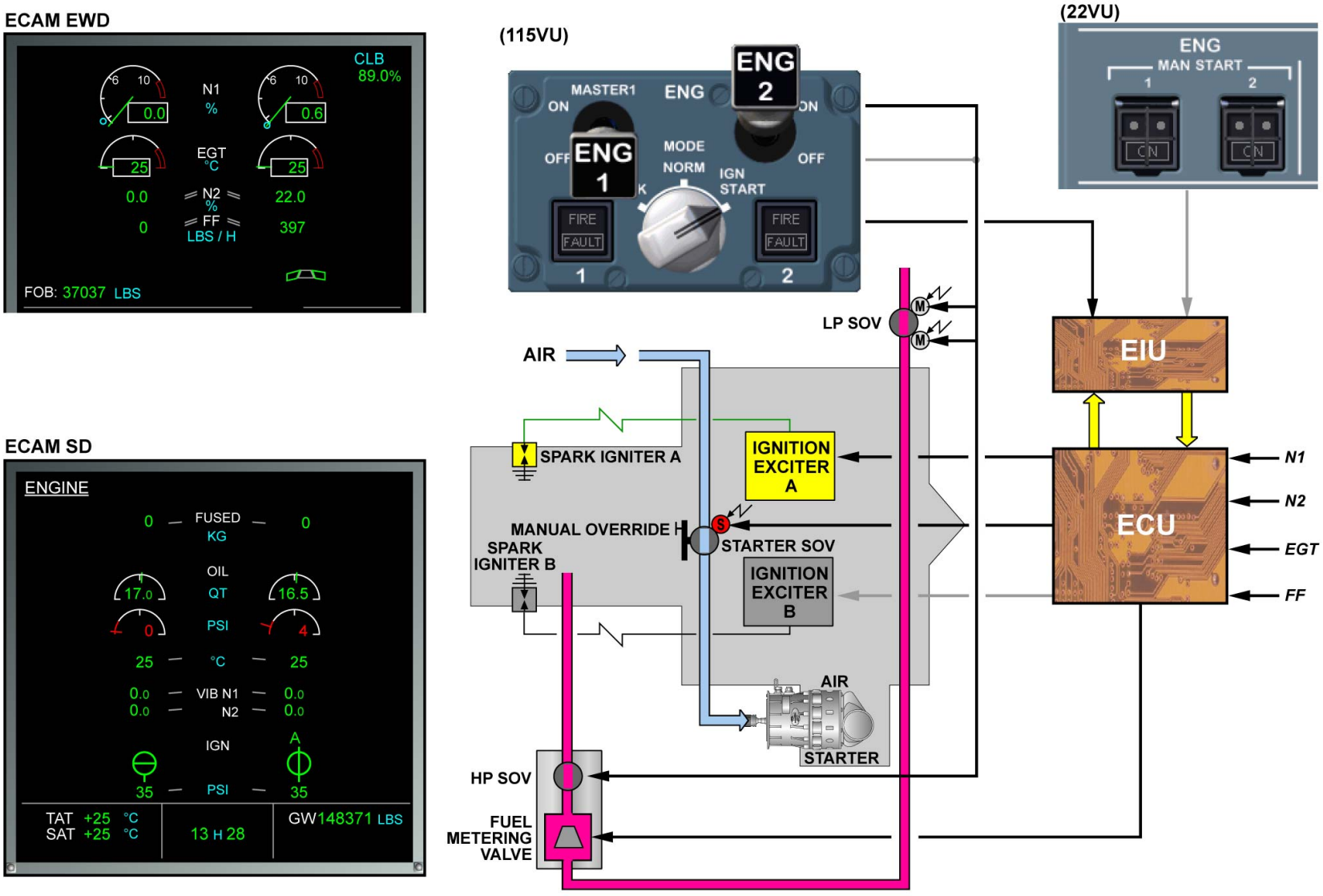
AUTOMATIC START



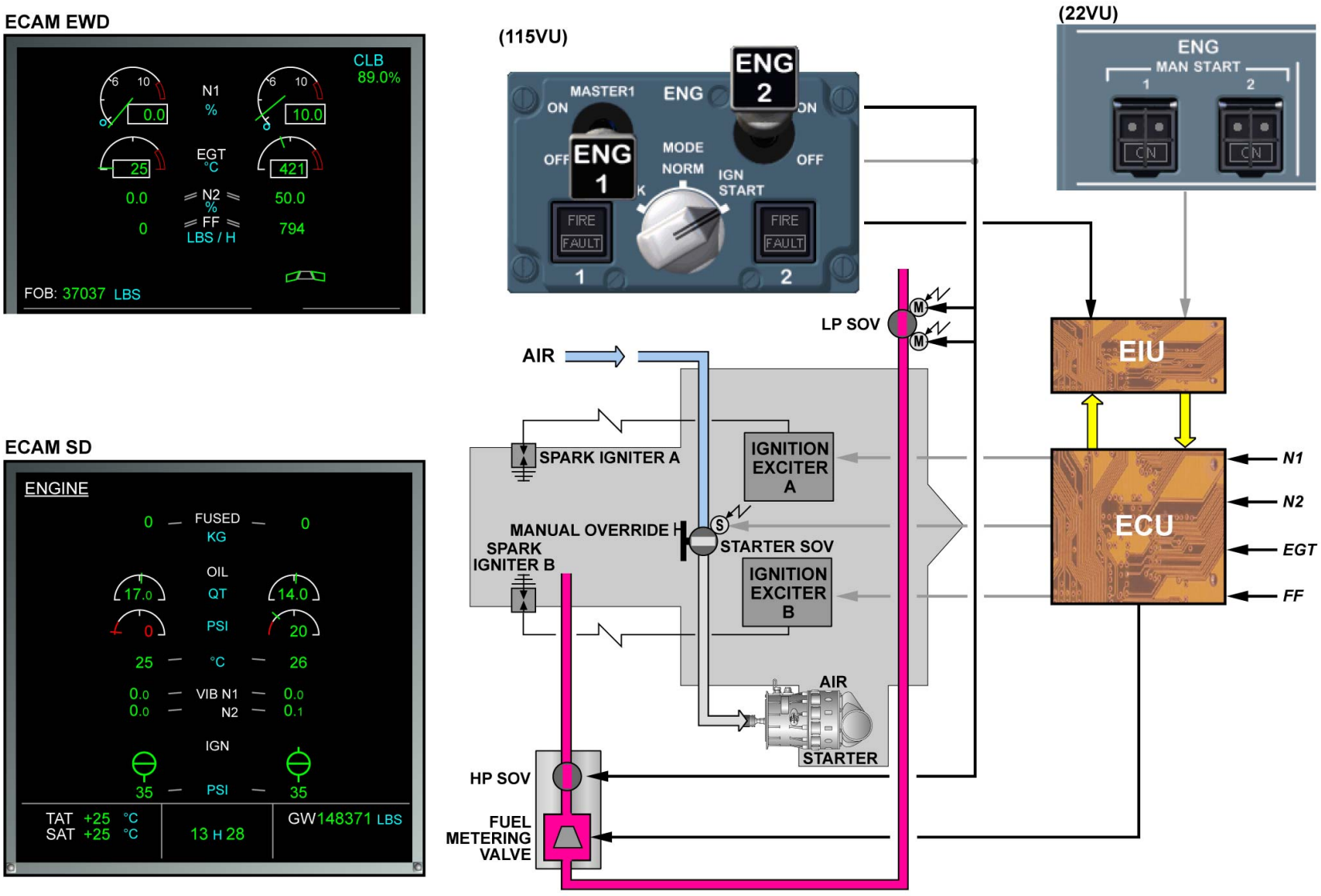
AUTOMATIC START



AUTOMATIC START



AUTOMATIC START



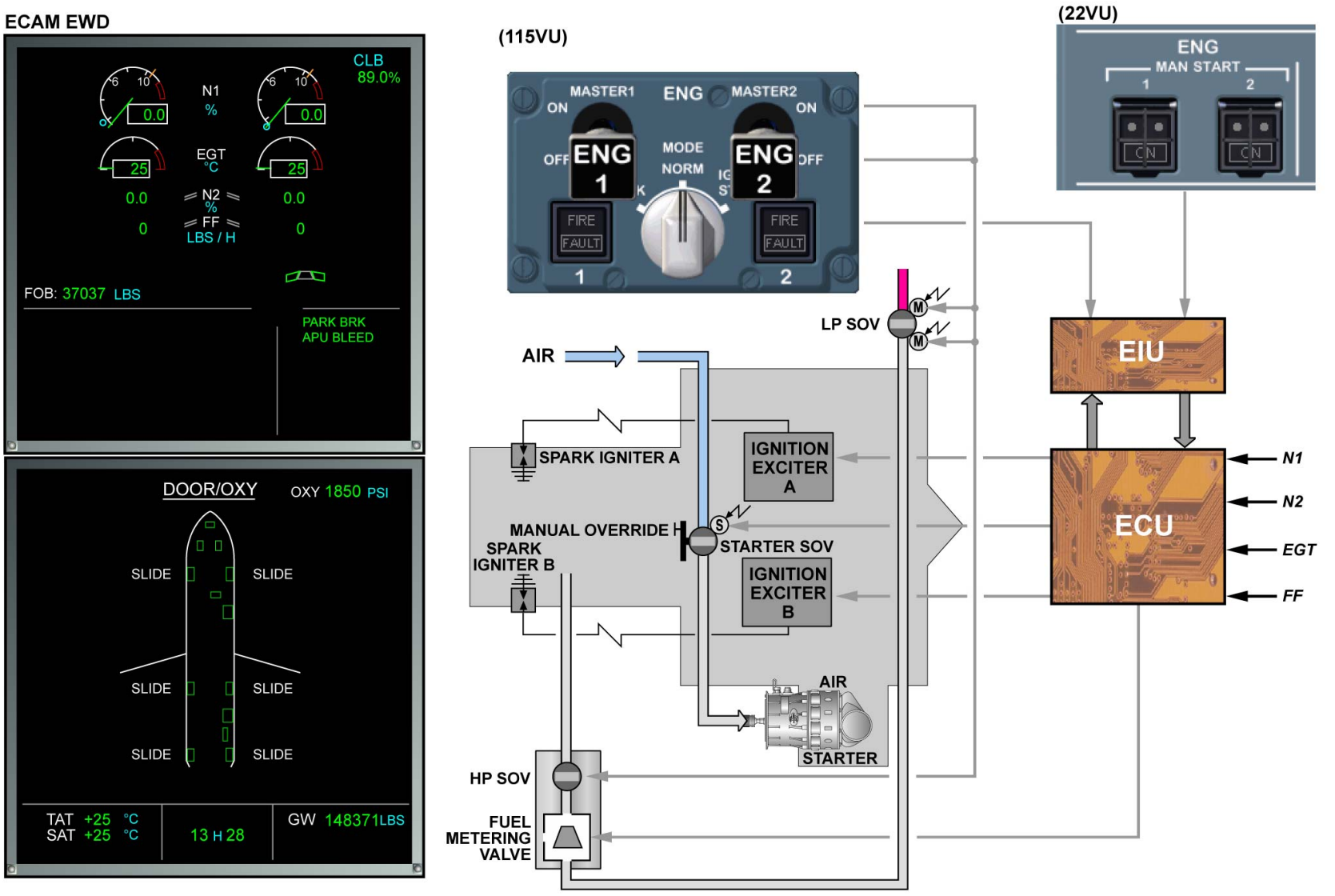
AUTOMATIC START

IGNITION & STARTING SYSTEM D/O (US) (3)

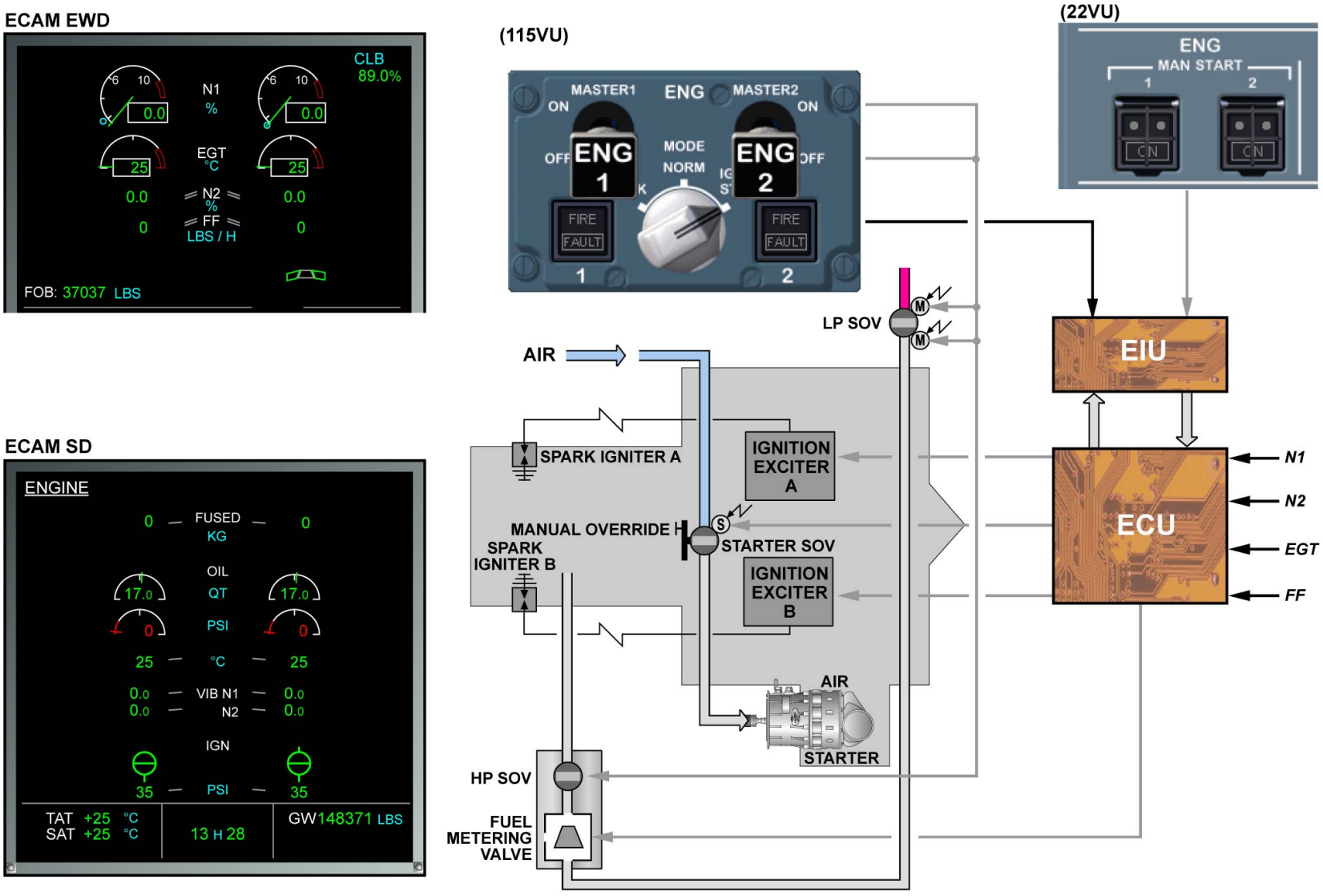
MANUAL START

Start sequence in manual mode.
The aircraft configuration:
- APU running and APU BLEED on,
- FADEC 1 and 2 powered.

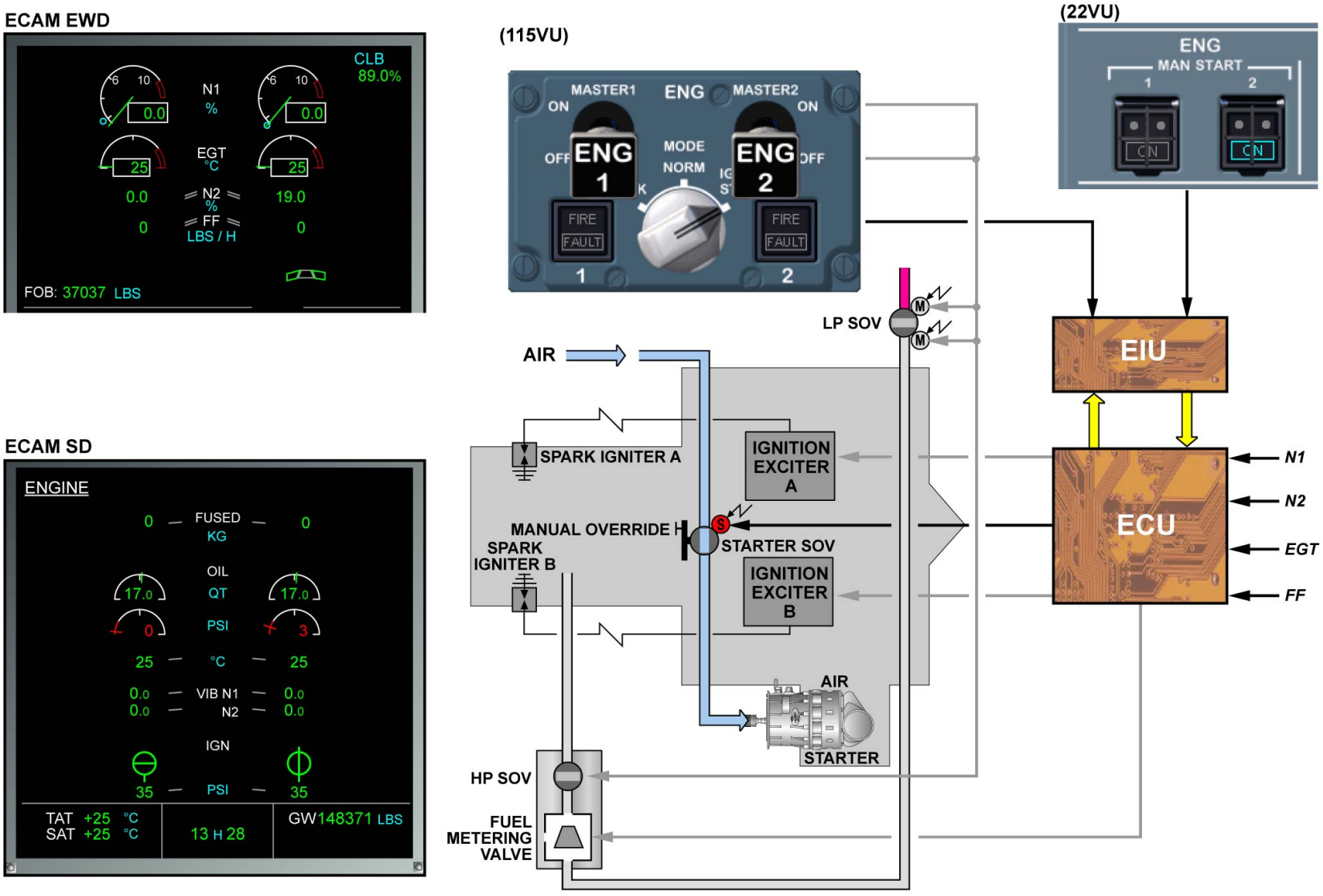
When IGNition START is selected the ENGINE page is called automatically. During start the ENGINE page displays IGN indication, starter SOV position and bleed pressure.
During this time the pack valves are automatically closed. If, after 30 seconds, the ENGine MANual START P/B is not switched ON, the pack valves will re-open.
Selecting the ENGine MANual START P/B opens the starter SOV. After that, the N2 begins to increase and, when it is at least 20% N2, the MASTER control switch must be set to the ON position.
Before the MASTER control switch is set to ON, it is possible to interrupt the sequence by selecting the MANual START P/B switch to OFF.
As soon as the MASTER control switch is set to the ON position, both ignition systems are energized, LP and HP SOV are opened and fuel flow increases.
At 20% of N2 with the MASTER control switch at ON, dual ignition and fuel flow are initiated.
The ECU monitors the EGT and N2, according to their schedules, to provide the correct fuel flow. The maximum EGT during start sequence is 725º C.
In case of malfunction, set the MASTER control switch to OFF to perform a start abort sequence. In manual starts there is no automatic shutdown function.
Up to 50% of N2, the automatic fuel flow regulation is performed. When N2 reaches 50%, the ECU automatically closes the starter SOV and cuts off the ignition.
The pack valves re-open after 30 seconds.
Engine 2 is now stabilized at minimum idle.
To start the other engine, set the ENGine 1 MANual START P/B to ON, keeping the selector in the IGNition START position and then, when N2 reaches 20%, set the MASTER control switch 1 to ON.
After engine start, the selector is set back to MODE NORMal position.
With the selector in this position and one engine running, the WHEEL page appears instead of the ENGINE page.
If IGNition START is re-selected, continuous ignition is initiated on the running engine(s).
To complete the start sequence, the MANual START P/B is released out.
The action on the MANual START P/B has no effect on the starter SOV which has already been automatically closed at 50% of N2, it is only done to complete the manual start procedure.



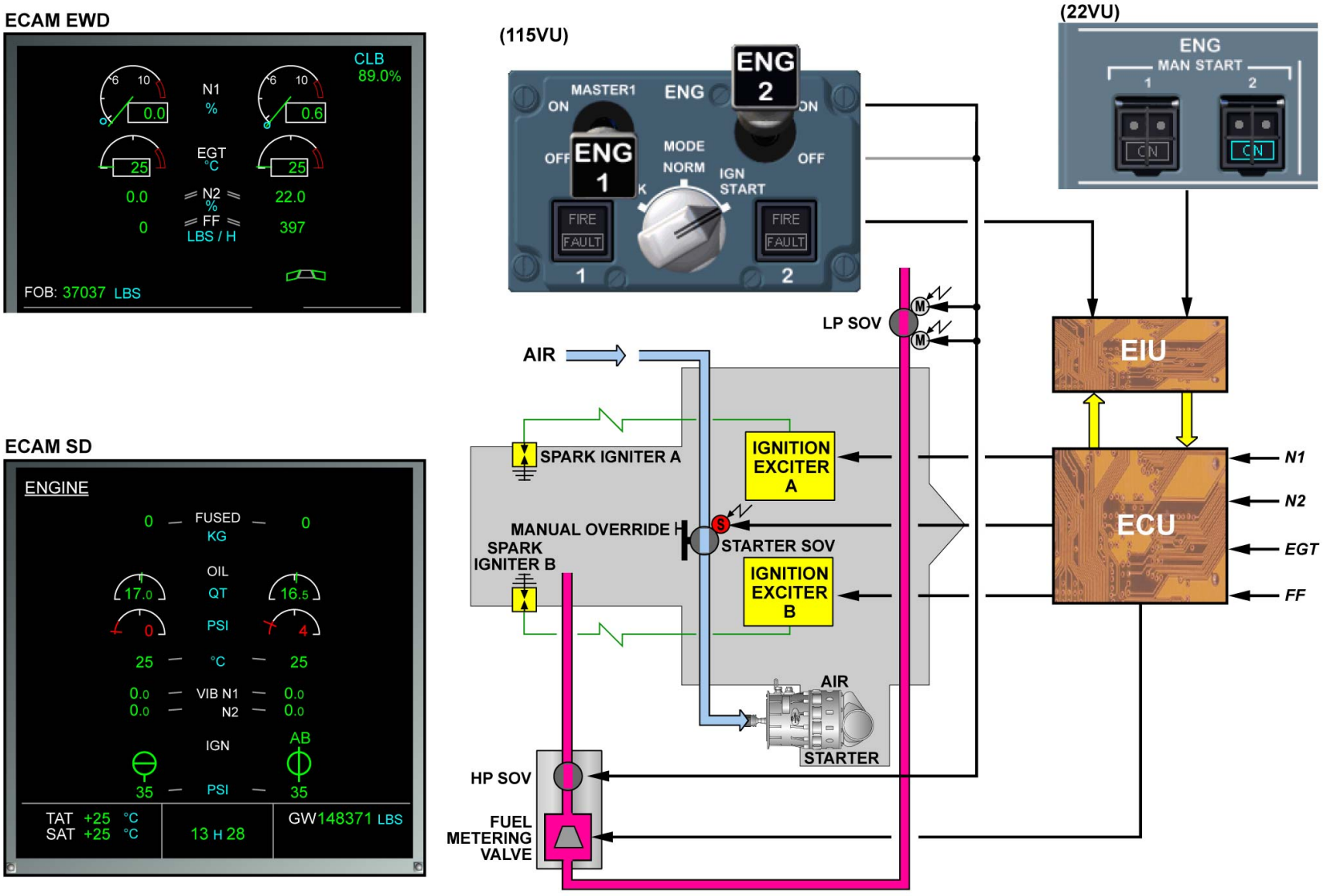
MANUAL START



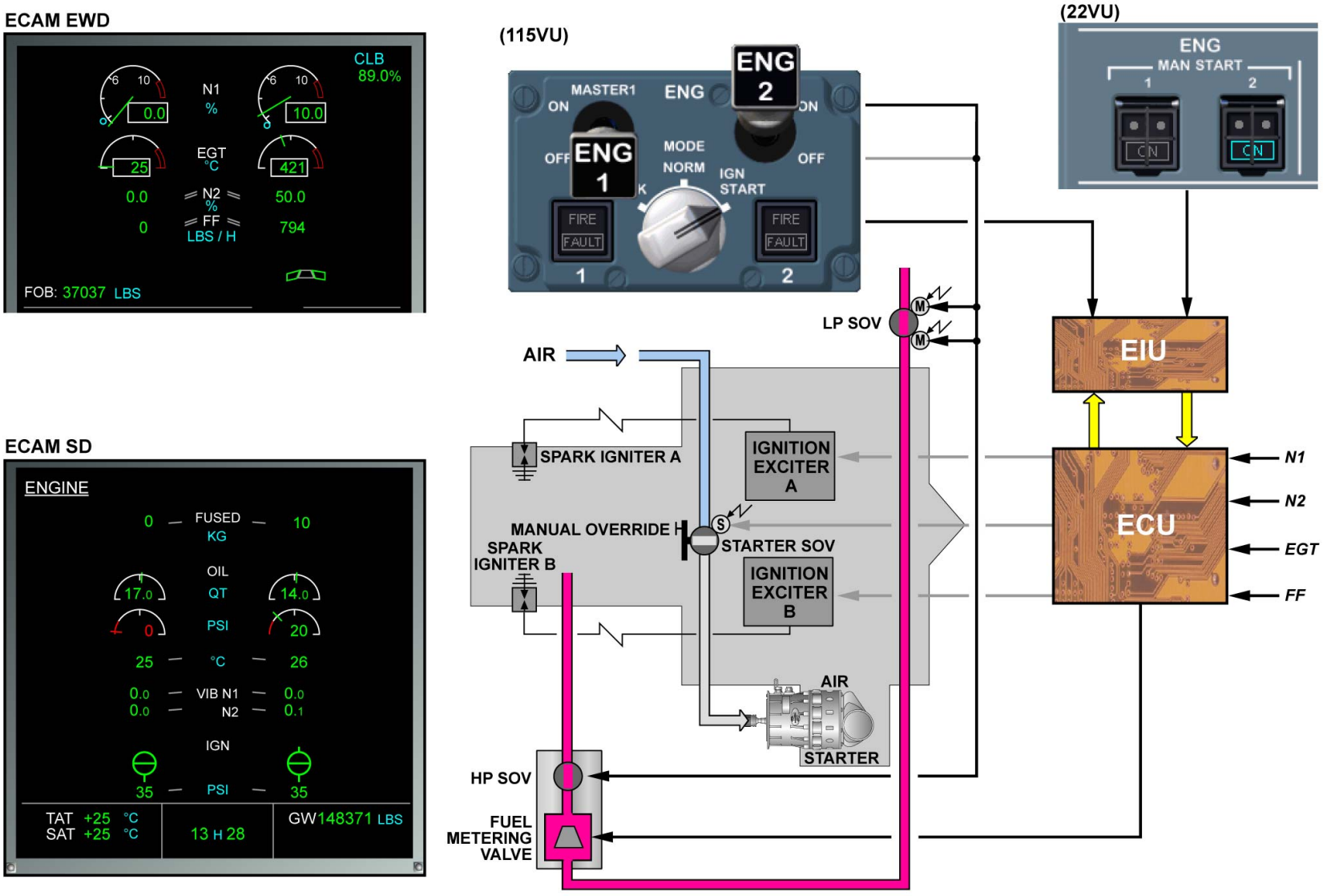
MANUAL START



MANUAL START



MANUAL START



MANUAL START

IGNITION & STARTING SYSTEM D/O (US) (3)

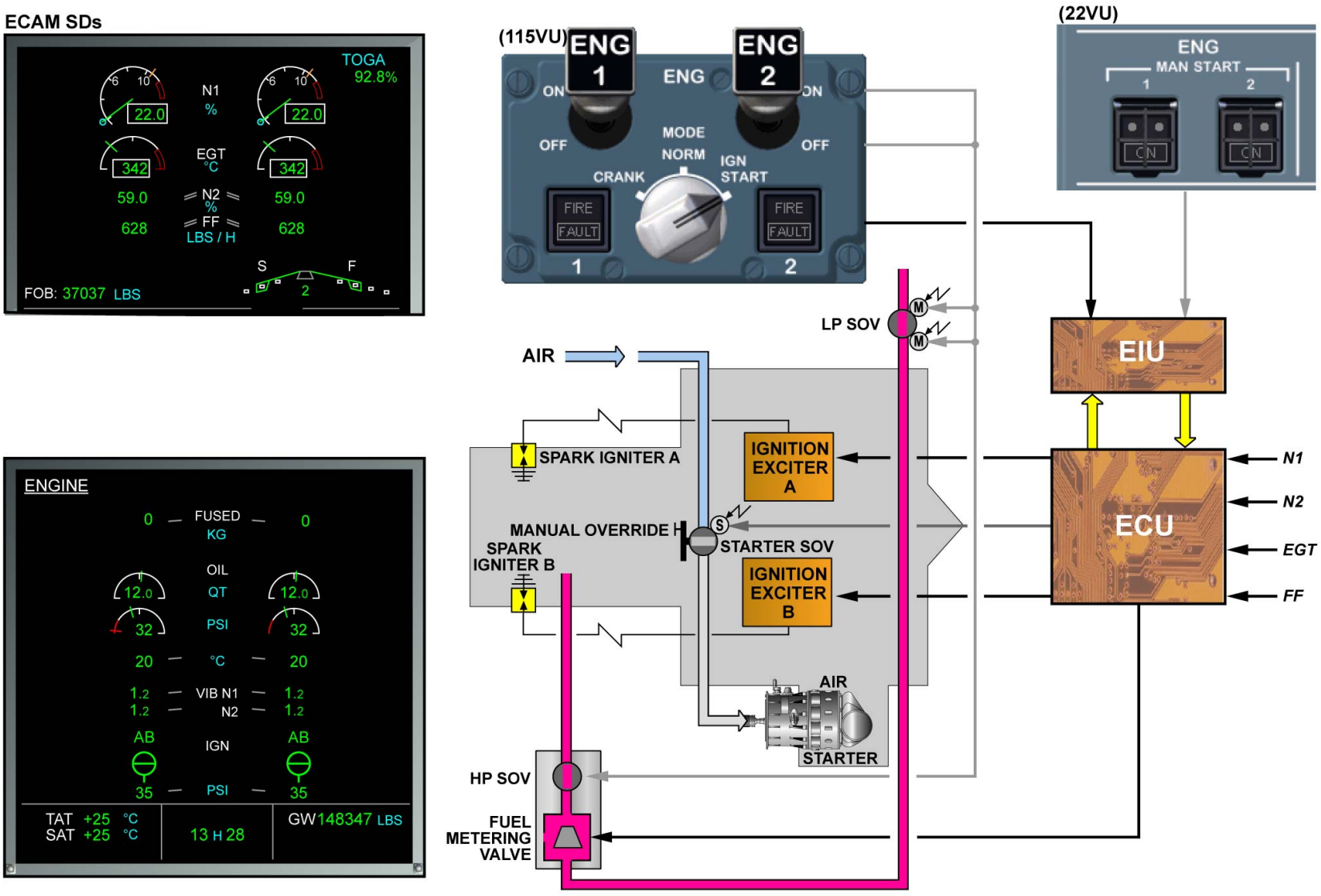
CONTINUOUS RELIGHT

Continuous relight.
The aircraft configuration in this case is the following:
- APU running and APU BLEED on,
- engine 2 running.

Continuous ignition is manually selected or automatically controlled by the FADEC.
If IGNition START is re-selected with an engine running, the corresponding ECU supplies the two igniters together, to provide a permanent ignition.
The automatic selection is provided by the FADEC when:
- Engine Interface Unit (EIU) failed,
- engine flame-out detected,
- ignition delay is sensed during start,
- in flight restart.

The continuous relight is cut off in MODE NORMal.

UG913131 - U7RT0EC - UM74D1CFM000002



CONTINUOUS RELIGHT

UG913131 - U7RT0EC - UM74D1CFM000002

IGNITION & STARTING SYSTEM D/O (US) (3)

ENGINE CRANK

DRY CRANK

Engine CRANK modes:
- dry CRANK,
- wet CRANK.

The aircraft configuration in this case is the following:
- APU running and APU BLEED on,
- FADEC 1 and 2 powered,
- both engines shut down,
- C/B 1KC1(2) (ENGINE HP FUEL SOV) opened (dry crank only) to open the LP SOV. Fuel inlet pressure has to be positive (dry crank and wet crank).

When CRANK is selected on the ground, the ENGINE page appears automatically on the ECAM and the ECU initiates a motoring sequence after action on the MANual START P/B.

With CRANK selected, ignition is inhibited.

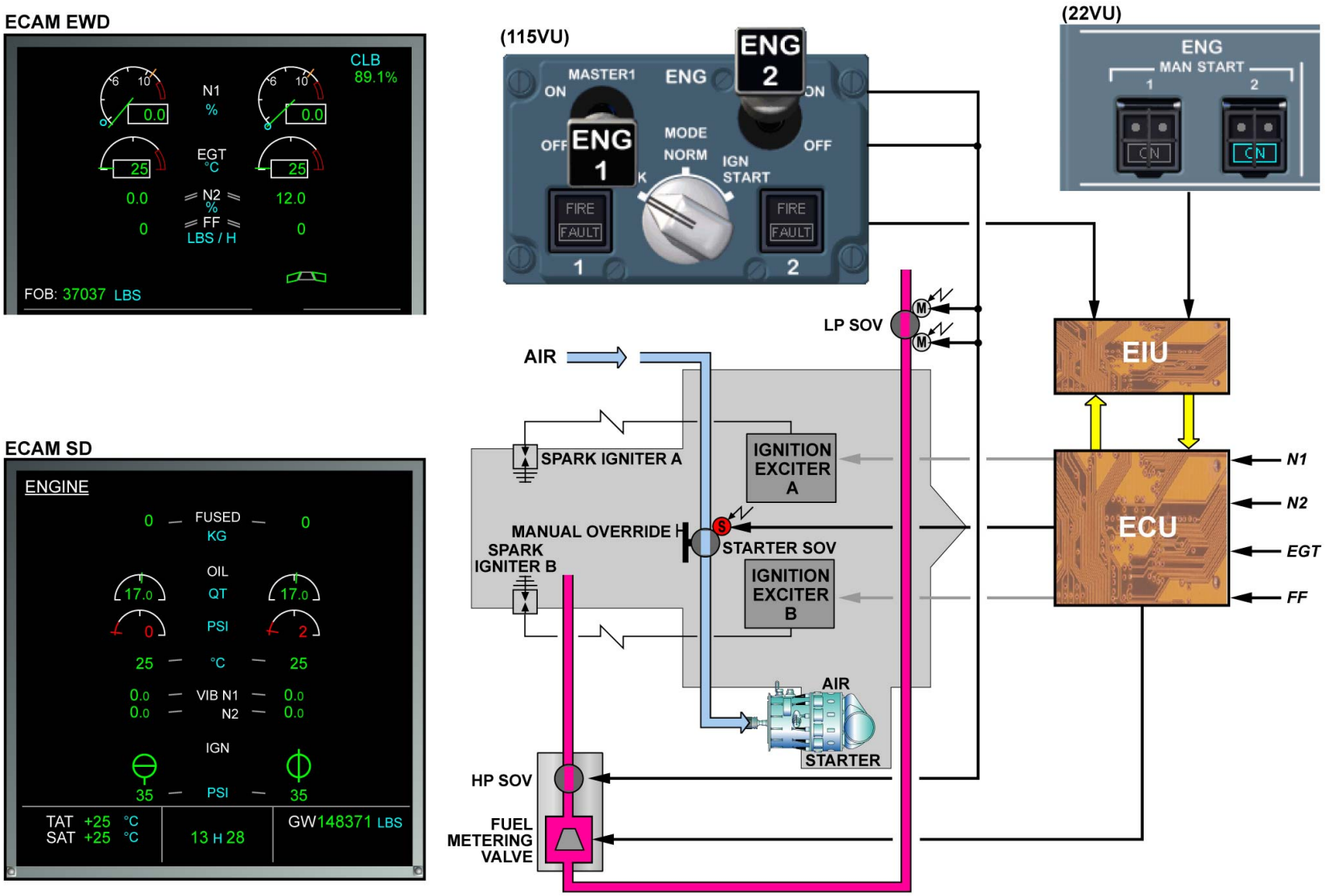
The action on the ENGine MANual START P/B opens the starter SOV.

During the crank sequence the starter limitations have to be observed. Make sure that you do not go over the limits.

An acceptable duty cycle can be performed with the following procedure:
- 2 minutes on,
- 20 seconds off,
- up to four times and then,
- 15 minutes off for cooling.

If the starter operation time is exceeded, a warning message is displayed on the ECAM.

UG913131 - U7RT0EC - UM74D1CFM000002



ENGINE CRANK - DRY CRANK

IGNITION & STARTING SYSTEM D/O (US) (3)

ENGINE CRANK (continued)

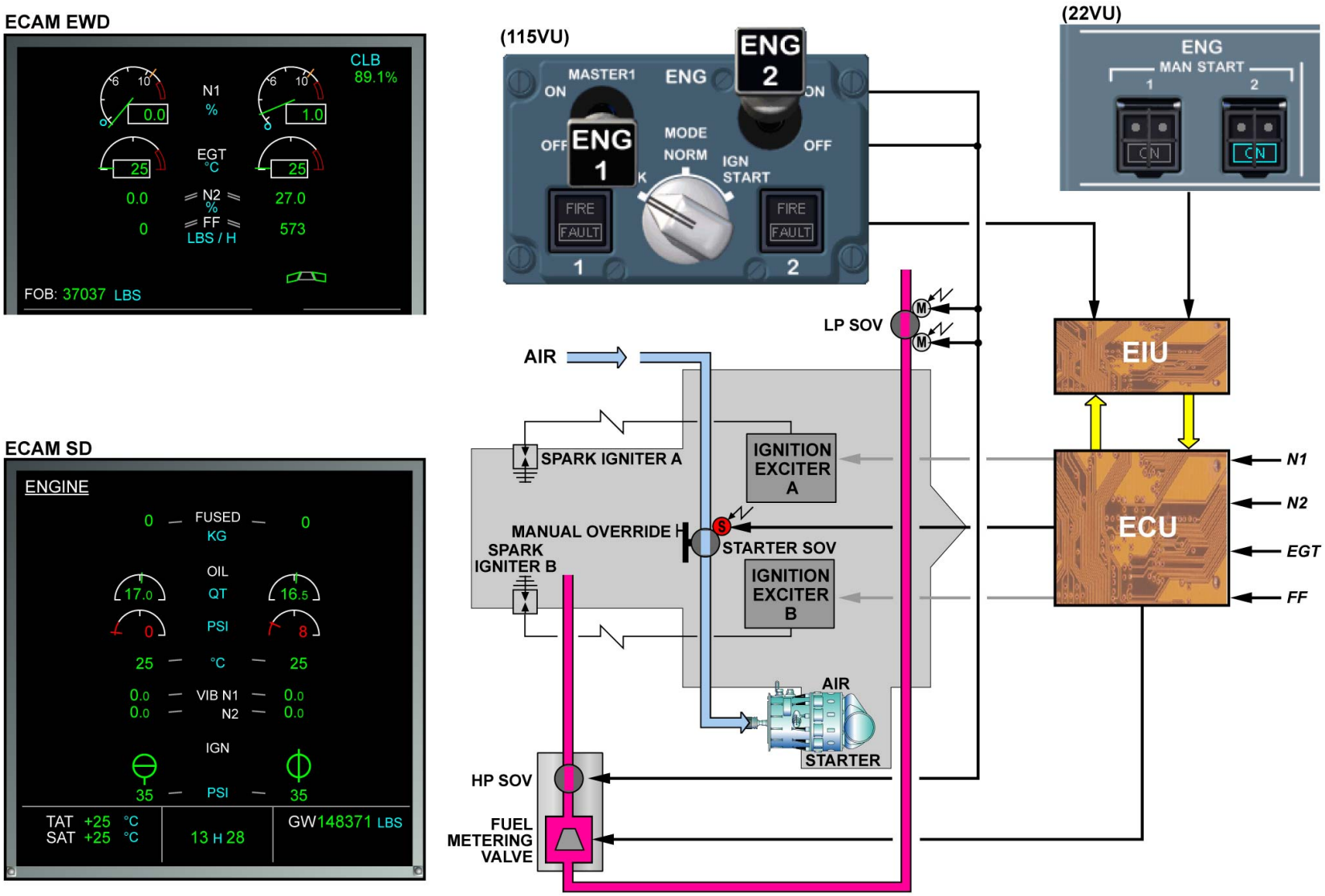
WET CRANK

When the MASTER control switch is set to the ON position, the LP and HP fuel SOV are opened.
For a wet crank, the MASTER control switch is normally set to ON between 15 and 20% of N2.

CAUTION: - DO NOT MOTOR THE ENGINE FOR MORE THAN 15 SECONDS WITH THE MASTER CONTROL SWITCH IN THE ON POSITION.

After a wet crank of 15 seconds maximum, when the MASTER control switch is set to the OFF position, the fuel is cut off and the starter SOV closes following the reset of the ECU.
After the reset of the ECU, the ECU will command the starter SOV to open when the N2 speed is less than 10%. The dry CRANK procedure is initiated.
Continue to dry crank the engine for 60 seconds (within the starter limitation of 2 minutes on), this will dry the fuel that can be in the combustor.
After 60 seconds, release the MANual START P/B switch to interrupt the crank sequence and set the selector back to MODE NORMal position.
When the MANual START P/B is released out, the starter SOV closes.
With the selector in the MODE NORM position and engines shut down, the DOOR/OXYgen page is displayed on the ECAM.

UG913131 - U7RT0EC - UM74D1CFM000002



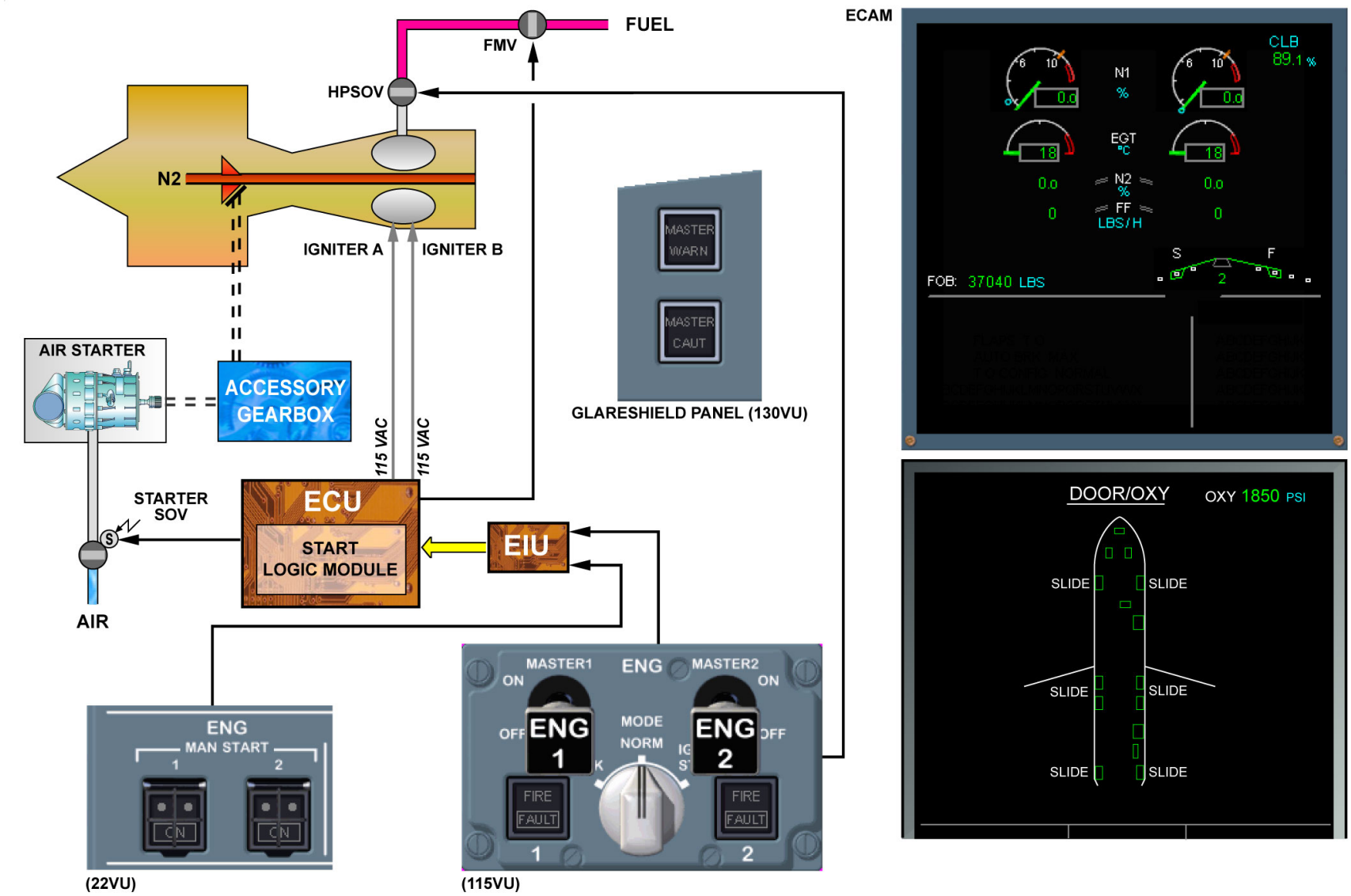
ENGINE CRANK - WET CRANK

START FAILURES (US) (3)

GENERAL

The aircraft configuration for each fault is:
- APU bleed ON,
- Full Authority Digital Engine Control (FADEC) 1 and 2 powered,
- and residual Exhaust Gas Temperature (EGT) is Outside Ambient Temperature (OAT).

UG913131 - U7RT0EC - UM74D2CFM000002


FUEL
FMV
HPSOV
N2
IGNITER A
IGNITER B
AIR STARTER
ACCESSORY GEARBOX
115 VAC
115 VAC
STARTER SOV
ECU
START LOGIC MODULE
EIU
AIR
MASTER WARN
MASTER CAUT
GLARESHIELD PANEL (130VU)
ENG
MAN START
1
2
CN
CN
(22VU)
MASTER1
ENG
MASTER2
ON
ON
OFF
ENG 1
MODE
NORM
ENG 2
OFF
FIRE
FAULT
FIRE
FAULT
1
2
(115VU)
ECAM
CLB
89.1 %
N1
%
EGT
°C
N2
%
FF
LBS/H
FOB: 37040 LBS
DOOR/OXY
OXY 1850 PSI
SLIDE
SLIDE
SLIDE
SLIDE
SLIDE
SLIDE

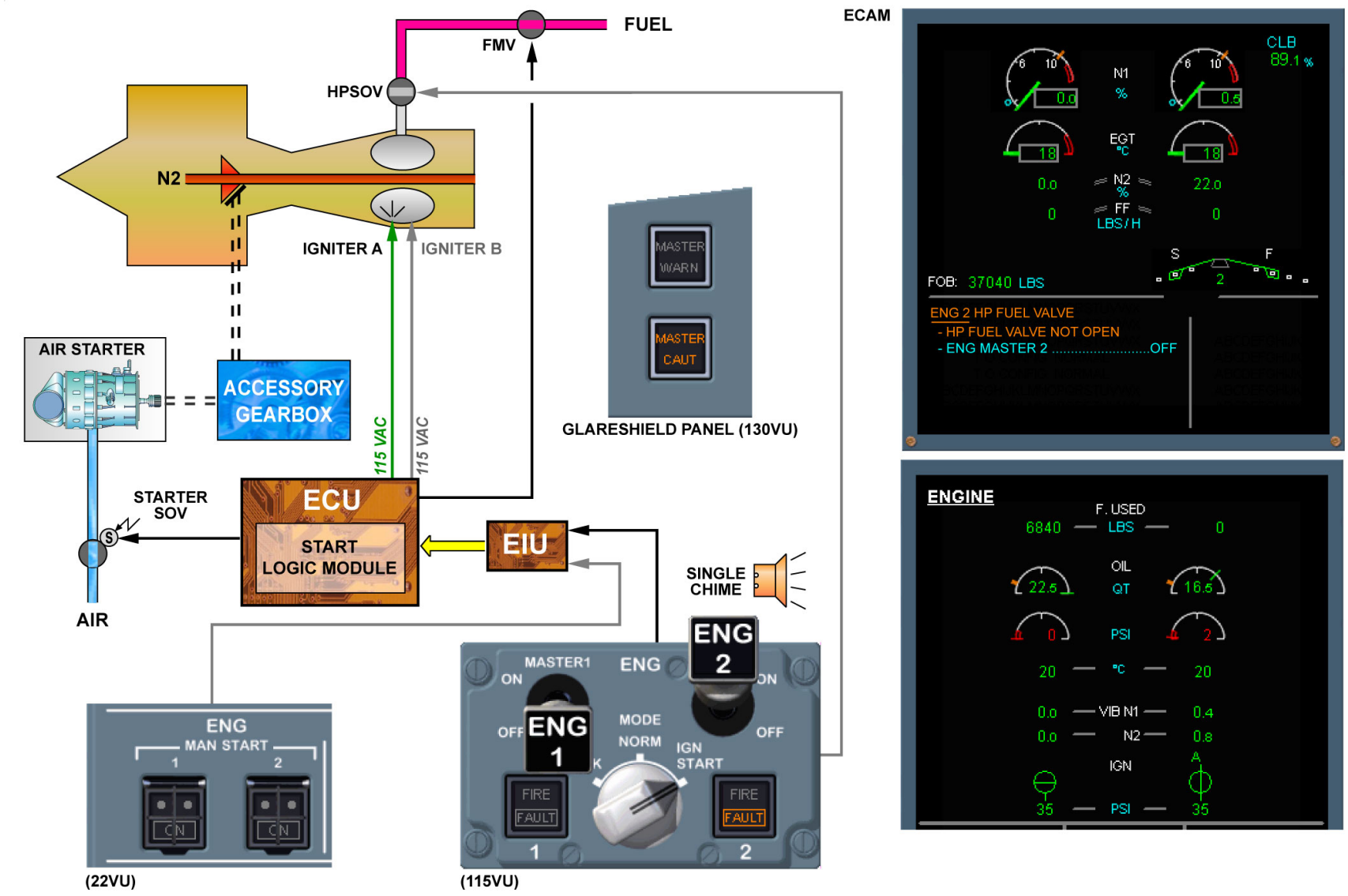
GENERAL

START FAILURES (US) (3)

HIGH PRESSURE FUEL VALVE NOT OPEN FAULT IN AUTOMATIC MODE

If the High Pressure (HP) fuel valve does not open, an aural warning sounds, the MASTER CAUTion and the engine Fault lights come on and an ECAM message appears.
The FADEC has detected an HP fuel valve failure and the operator has to manually abort the sequence following the next steps:
- first set the MASTER control switch to off,
- and finally set the mode selector to the MODE NORMal position.

UG913131 - U7RT0EC - UM74D2CFM000002

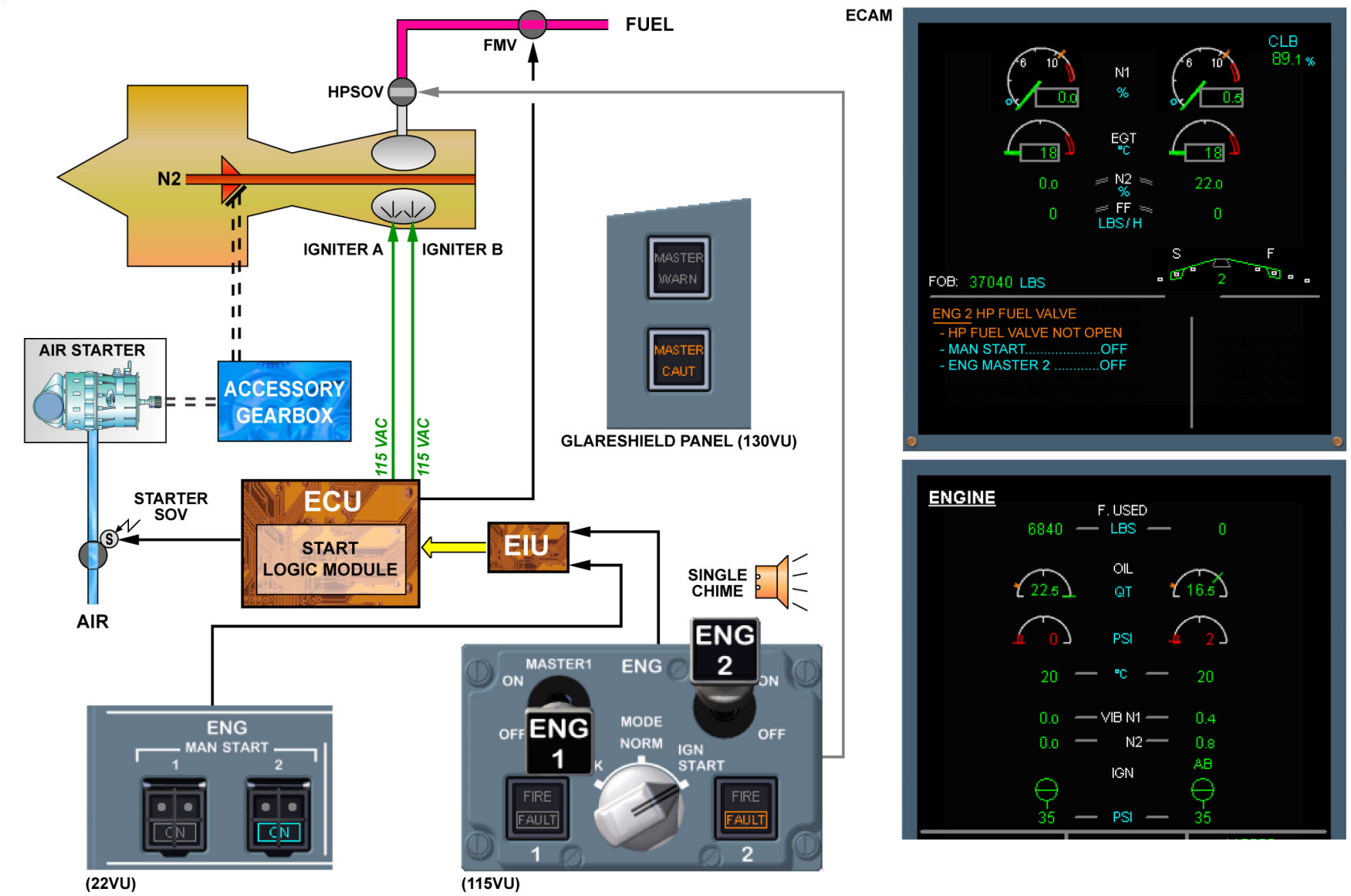


HIGH PRESSURE FUEL VALVE NOT OPEN FAULT IN AUTOMATIC MODE

START FAILURES (US) (3)

HIGH PRESSURE FUEL VALVE NOT OPEN IN MANUAL MODE

If the HP fuel valve does not open, an aural warning sounds, the MASTER CAUTion and the engine FAULT lights come on and an ECAM message appears.
The FADEC has detected an HP fuel valve failure and the operator has to manually abort the sequence following the next steps:
- first release the MANual START P/B and then set the MASTER control switch to off,
- and finally set the mode selector to the MODE NORMal position.



HIGH PRESSURE FUEL VALVE NOT OPEN IN MANUAL MODE

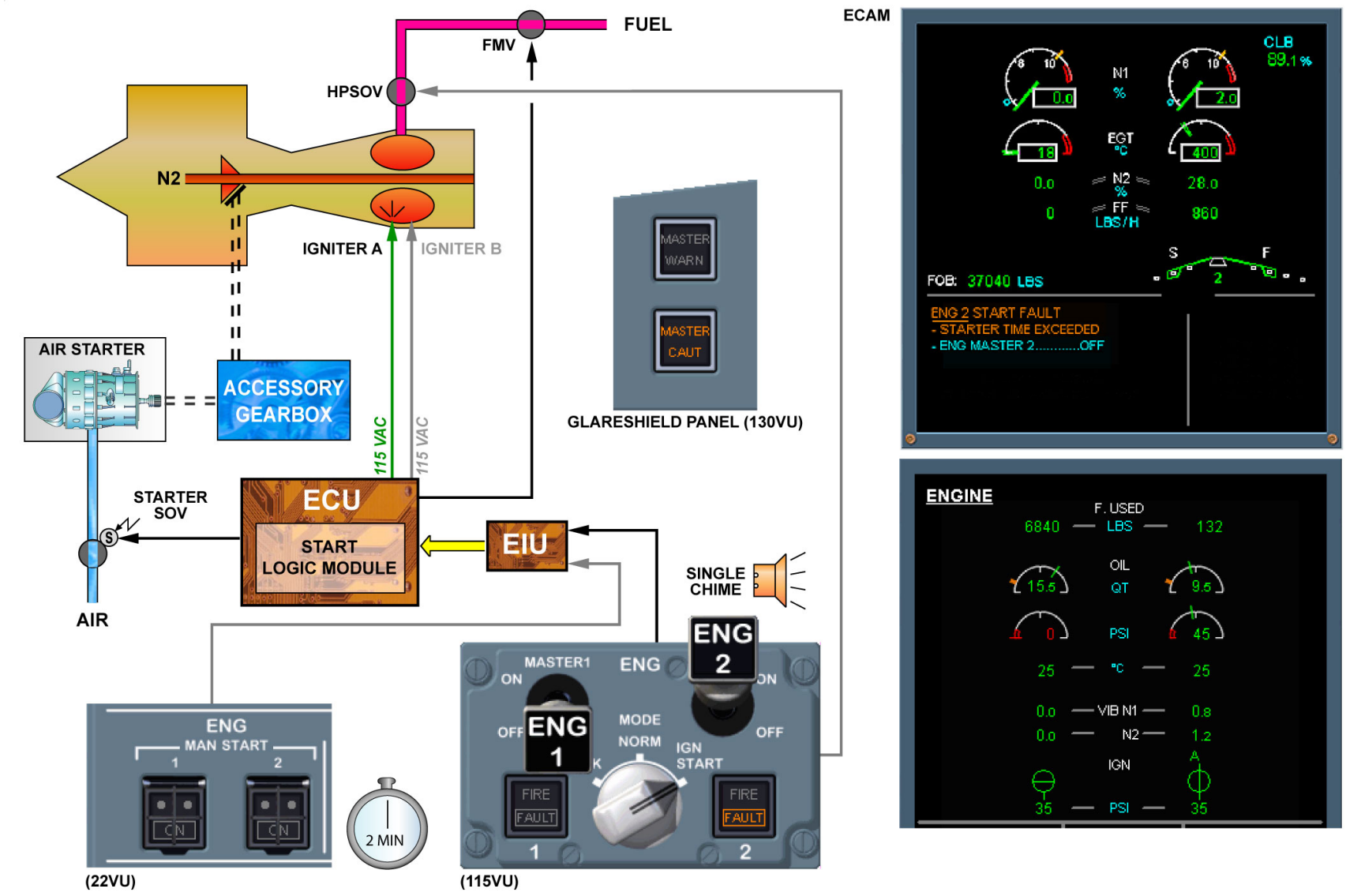
UG913131 - U7RT0EC - UM74D2CFM000002

START FAILURES (US) (3)

STARTER TIME EXCEEDED FAULT IN AUTOMATIC MODE

If the starter time is exceeded an aural warning sounds, the MASTER CAUTion comes on and an ECAM message appears.
The FADEC has detected a starter time exceedence and the operator has to manually abort the sequence setting the MASTER control switch to off and finally setting the mode selector to the MODE NORMal position.
The maximum starter time cycle is 2 minutes.
The starter limitations are the following:
- 4 consecutive cycles, each of 2 minutes maximum,
- 20 seconds of non operation between cycles,
- after 4 cycles, wait 15 minutes before attempting a new start,
- and no running engagement of the starter when N2 is above 20%.

UG913131 - U7RT0EC - UM74D2CFM000002

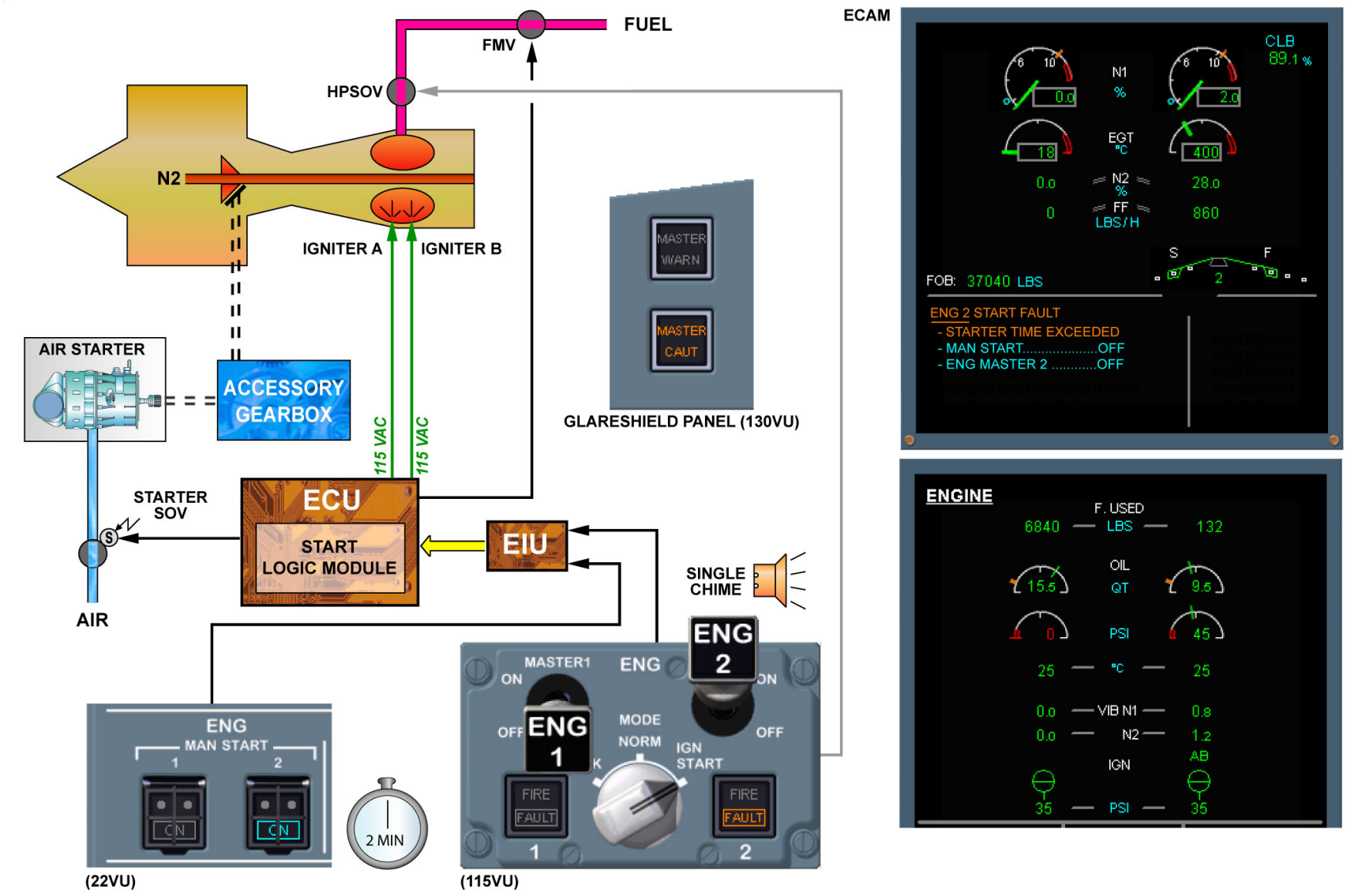


STARTER TIME EXCEEDED FAULT IN AUTOMATIC MODE

START FAILURES (US) (3)

STARTER TIME EXCEEDED FAULT IN MANUAL MODE

If the starter time limit is exceeded an aural warning sounds, the MASTER CAUTion comes on and an ECAM message appears.
The FADEC has detected a starter time exceedence and does not abort the start so the operator has to manually abort the sequence.
The maximum starter time cycle is 2 minutes, the same as in automatic mode.



STARTER TIME EXCEEDED FAULT IN MANUAL MODE

START FAILURES (US) (3)

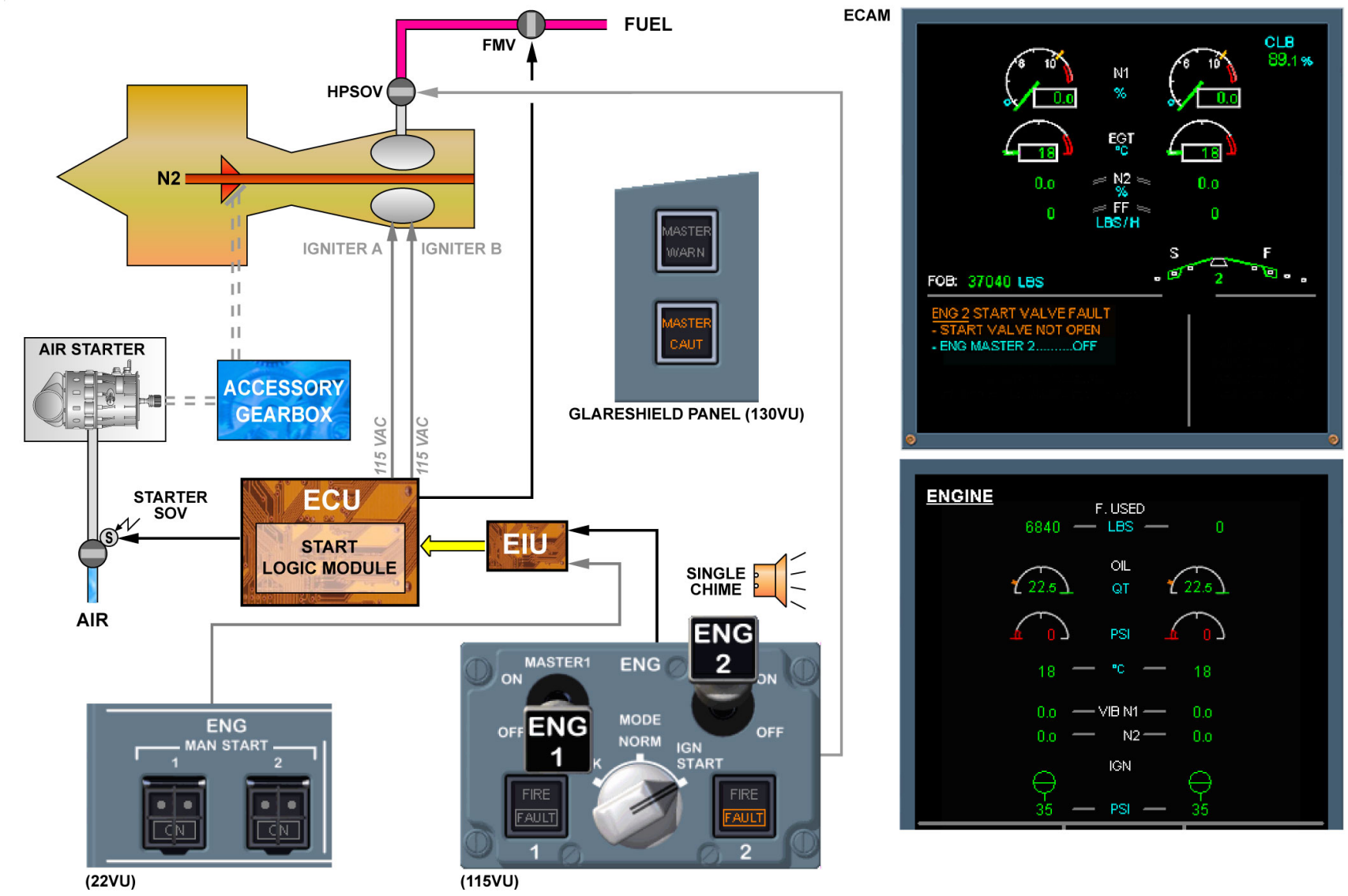
STARTER SHUT OFF VALVE NOT OPEN FAULT

If the starter Shut-Off Valve, (SOV), does not open, an aural warning sounds, the MASTER CAUTion and engine FAULT lights come on and an ECAM message appears.
Depending on the pneumatic system configuration, the flight crew can check the available pneumatic sources on the EWD:
- "X BLEED .....ON" appears on the ECAM.

If APU available:
- "APU BLEED.....ON" appears on the ECAM.

If the starter SOV is failed in the closed position then another start with a starter manual operation by the ground crew can be performed according to the next instructions.
Check on the ECAM engine page that pneumatic pressure is available at the starter SOV. Advise ground crew to prepare for a starter SOV manual operation.
Initiate a new automatic start by setting the Master Switch to OFF and then to ON again. Order the ground crew to open the starter SOV.
When N2 reaches 50 %, order the ground crew to close the starter SOV.
Finally continue with the normal procedure.

UG913131 - U7RT0EC - UM74D2CFM000002



STARTER SHUT OFF VALVE NOT OPEN FAULT

UG913131 - U7RT0EC - UM74D2CFM000002

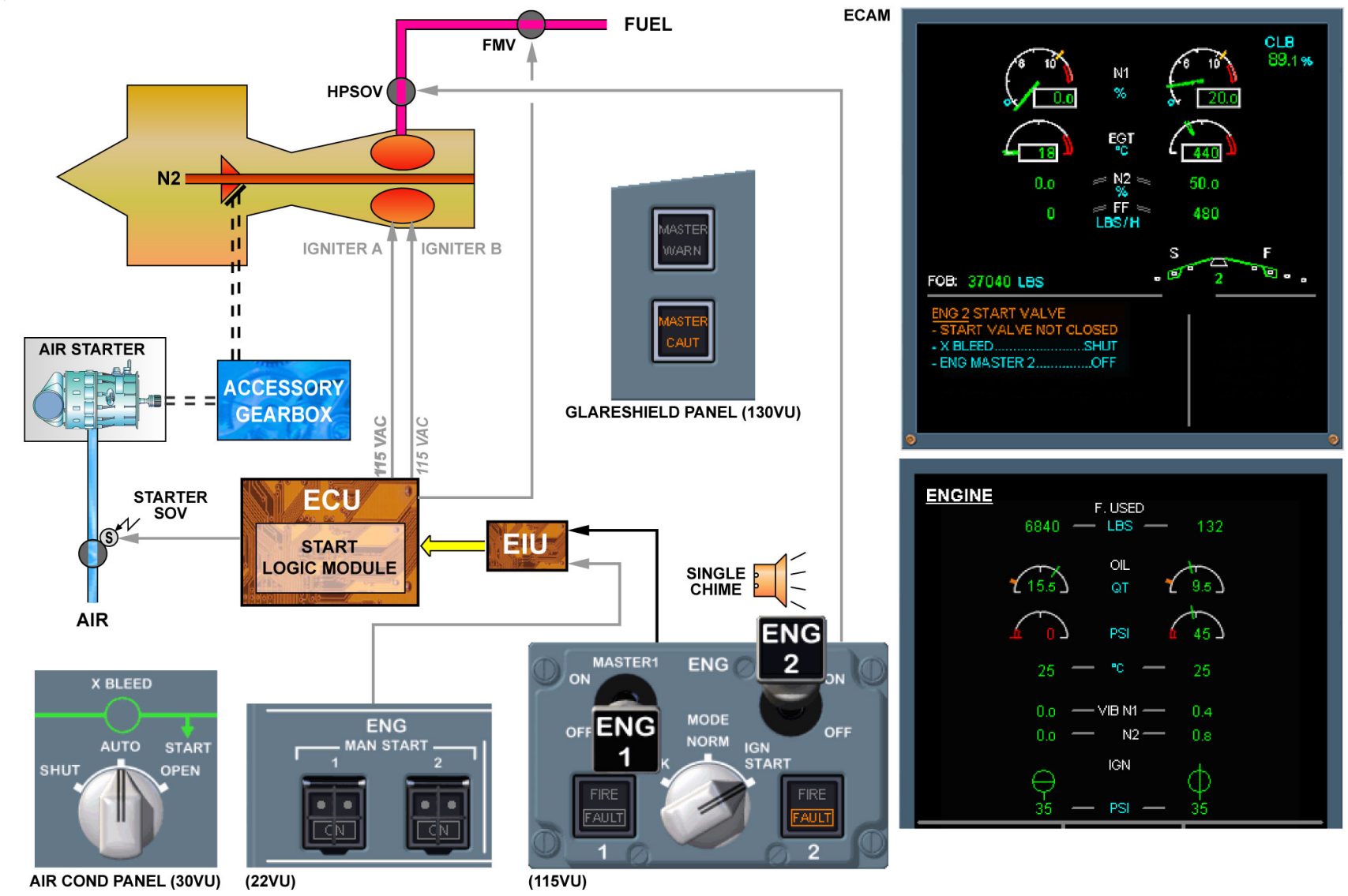
START FAILURES (US) (3)

STARTER SHUT OFF VALVE NOT CLOSED FAULT

At 50 % of N2, the FADEC sends a signal to close the starter SOV.
If the starter SOV does not close, an aural warning sounds the MASTER CAUTion and the engine FAULT lights come on and an ECAM message appears.
The starter SOV not closed procedure will be performed following the next instructions:
Remove all bleed sources supplying the faulty starter SOV setting the X BLEED selector to shut.
- APU BLEED (if ENG 1 affected)...OFF,
- X BLEED.....SHUT,
- and ENG MASTER 1(2).....OFF appears on the ECAM.

No restart is allowed, a maintenance action is required.

UG913131 - U7RT0EC - UM74D2CFM000002



STARTER SHUT OFF VALVE NOT CLOSED FAULT

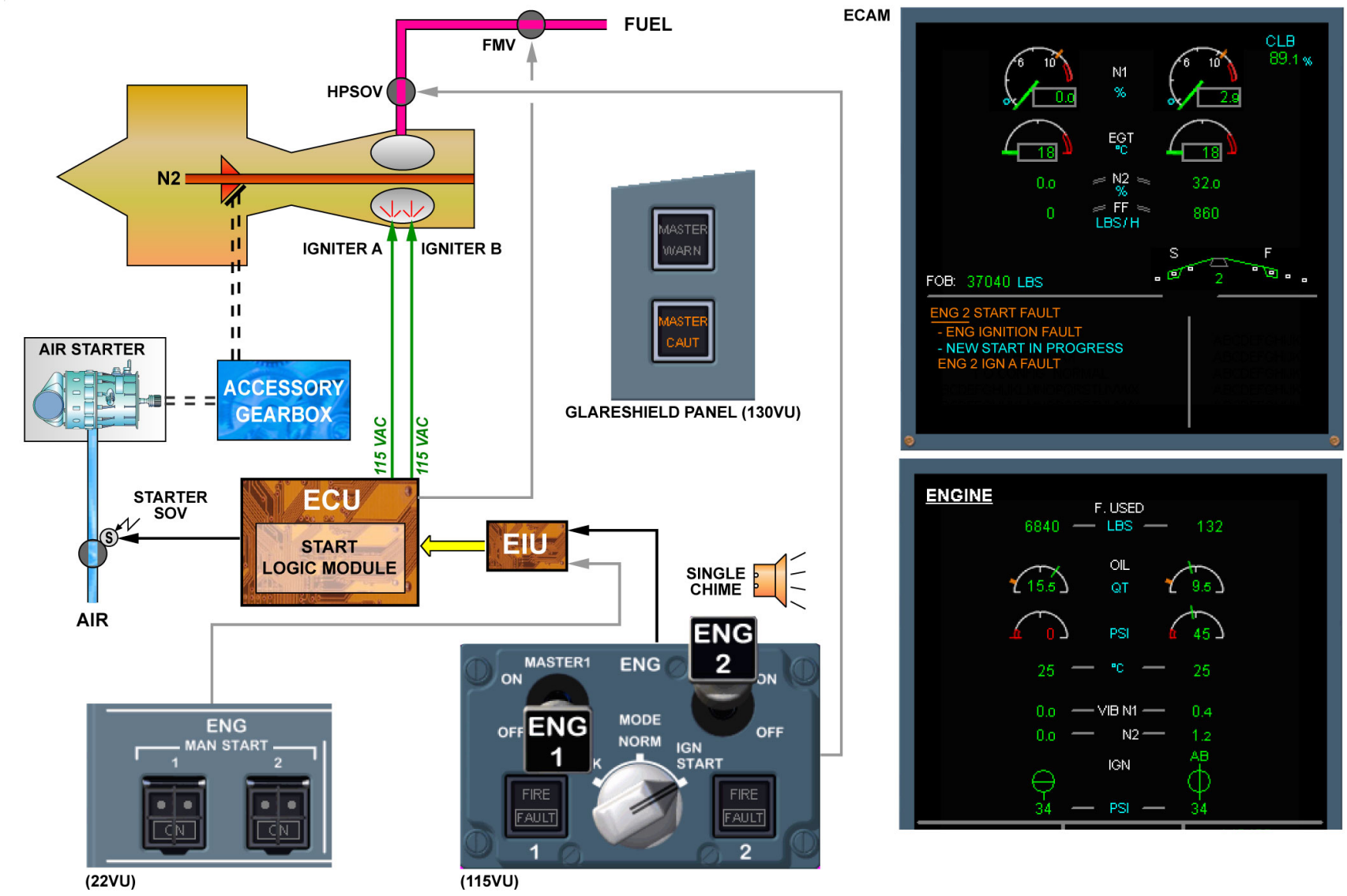
START FAILURES (US) (3)

IGNITION FAULT IN AUTOMATIC MODE

In this failure case the ECU will automatically perform 2 start attempts:
- 1 normal start,
- 1 additional attempt.

FIRST ATTEMPT

Select MODE selector to IGNition/START and ENGine MASTER control switch to ON.
The engine rotates, one ignitor is automatically turned ON at 16 % of N2 and fuel is automatically supplied at 22 % of N2.
If engine light-up is not obtained within 15 seconds, the FADEC automatically turns the ignition and the fuel OFF and dry cranks the engine for 30 seconds before initiating automatically a new start. An aural warning sounds, the MASTER CAUTion light comes on and an ECAM message appears.



IGNITION FAULT IN AUTOMATIC MODE - FIRST ATTEMPT

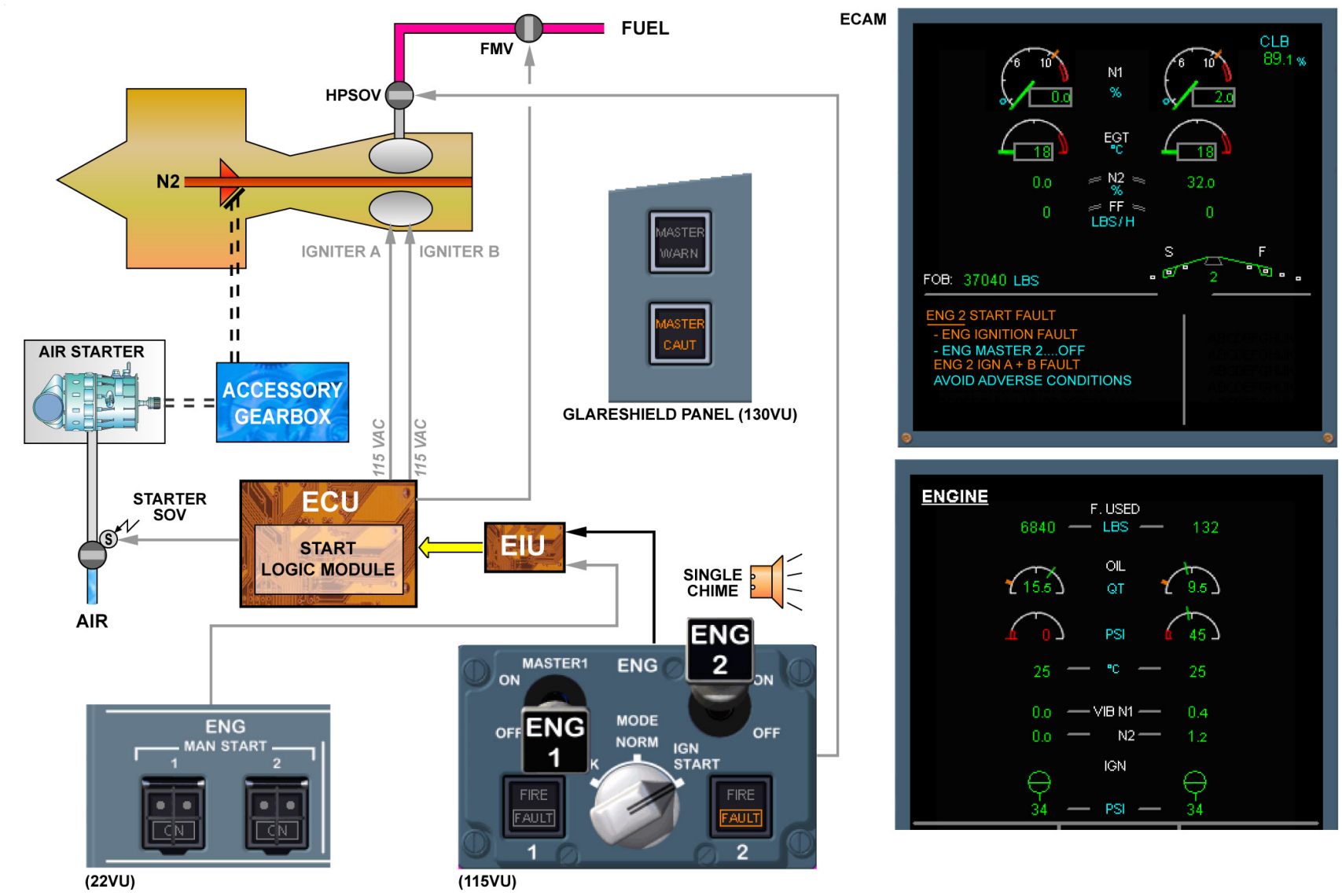
START FAILURES (US) (3)

IGNITION FAULT IN AUTOMATIC MODE (continued)

SECOND ATTEMPT

At the 25th second of the dry crank period, both ignitors are re-energized.
Five seconds later, the fuel is supplied, (A B indications are displayed on the ECAM page).
If engine light-up is not obtained within 15 seconds, the FADEC automatically cuts ignition and fuel, dry cranks for 30 seconds, aborts the autostart, turns the engine fault light on and displays an ECAM message to select the ENGine Master to OFF.

UG913131 - U7RT0EC - UM74D2CFM000002



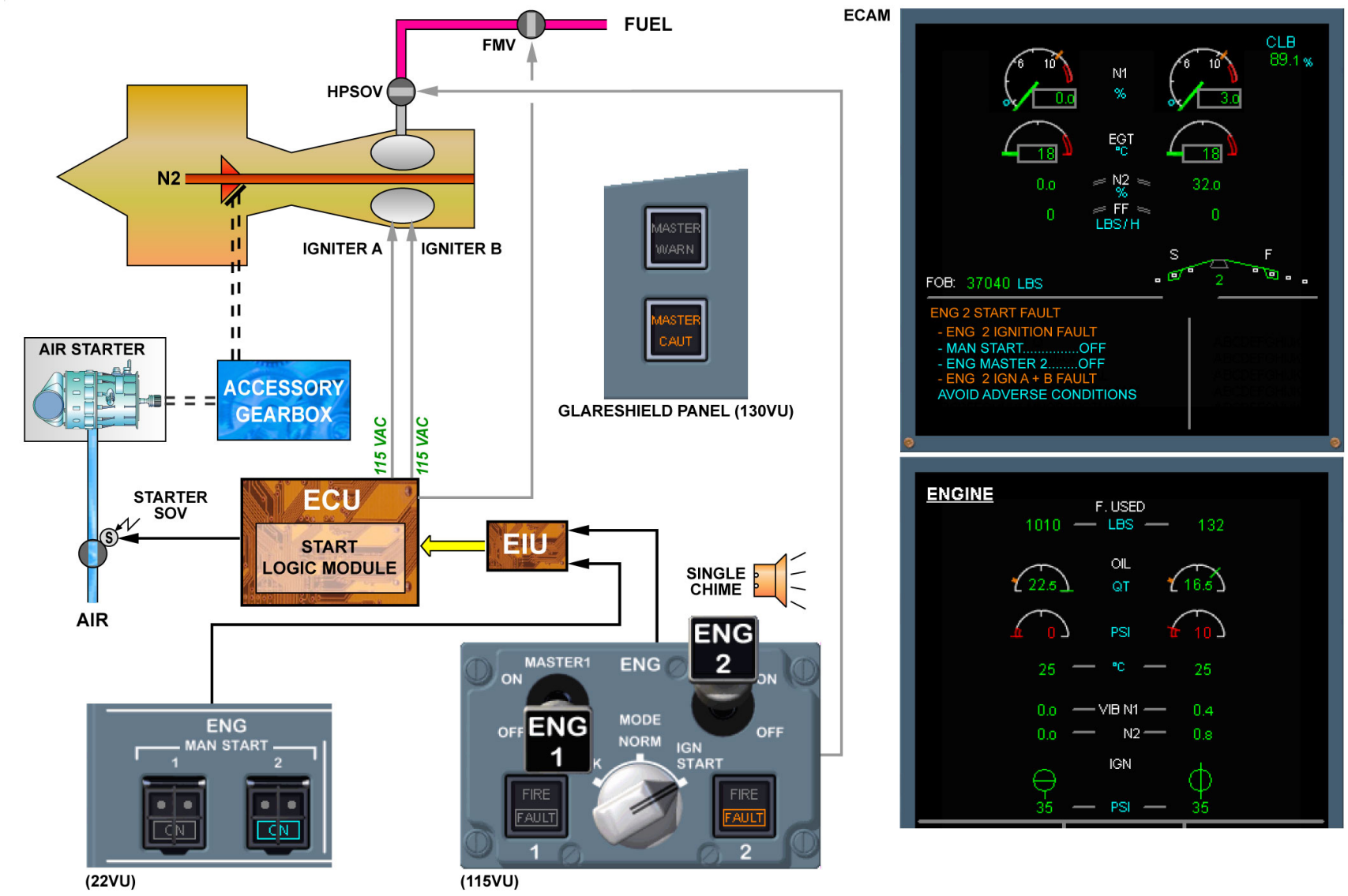
IGNITION FAULT IN AUTOMATIC MODE - SECOND ATTEMPT

START FAILURES (US) (3)

IGNITION FAULT IN MANUAL MODE

If an ignition fault occurs, an aural warning sounds, the MASTER CAUTion and the engine FAULT lights come on and an ECAM message appears.
In manual start, the FADEC does not abort the start, you must perform the following actions necessary to shut down the engine:
- first release the MANual START P/B,
- next set the MASTER control switch to off,
- and finally set the mode selector to the MODE NORMal position.

UG913131 - U7RT0EC - UM74D2CFM000002



IGNITION FAULT IN MANUAL MODE

UG913131 - U7RT0EC - UM74D2CFM000002

START FAILURES (US) (3)

EXHAUST GAS TEMPERATURE OVERLIMIT OR STALL FAULT IN AUTOMATIC MODE

In case of detected stall or EGT overlimit, the FADEC monitoring and the flight crew actions are identical.
4 start attempts will be performed, a normal start plus 3 additional attempts.

FIRST ATTEMPT

When a stall or an EGT overlimit is detected, an aural warning sounds, the MASTER CAUTion light comes on and an ECAM message appears.
The FADEC has detected a stall of the engine and will initiate a start abort, a crank and a restart sequence shutting off the fuel and ventilating the engine (crank time 7 seconds).

SECOND ATTEMPT

The FADEC reduces the fuel flow and attempts a second start. The fuel schedule reduction in the second start is 7 percent.
If the abnormality re-occurs a second time, the FADEC shuts off the fuel and ventilates the engine (crank time 7 seconds).

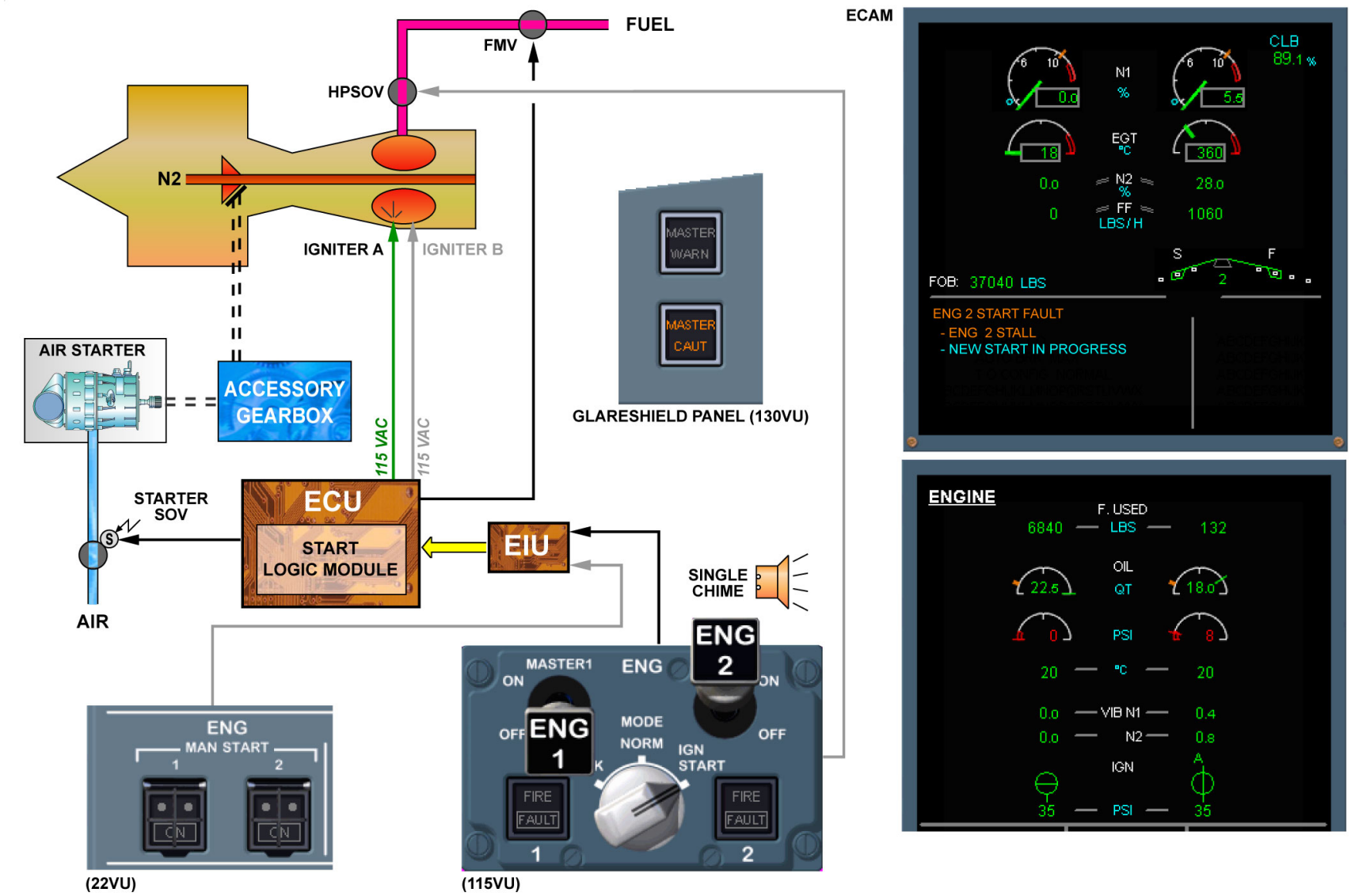
THIRD ATTEMPT

The FADEC reduces the fuel flow and attempts a third start. The fuel schedule reduction in the third start is 7 percent (a total of 14 percent).
If the abnormality occurs a third time, the FADEC shuts off the fuel and ventilates the engine (crank time 7 seconds).

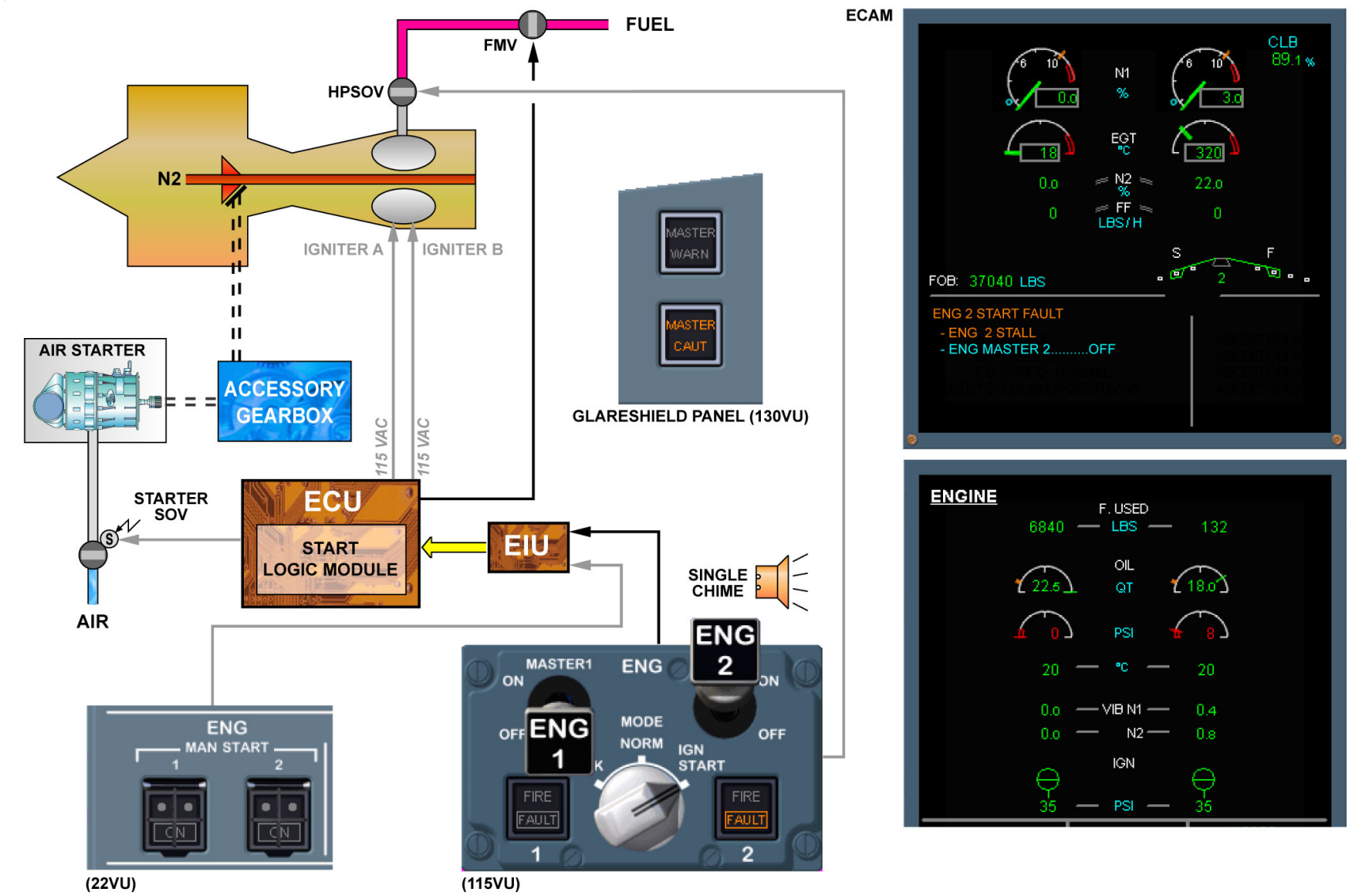
FOURTH ATTEMPT

After 7 seconds, the FADEC reduces the fuel flow again and attempts a fourth start. The fuel schedule reduction in the fourth start is 7 percent (a total of 21 percent).
If the abnormality occurs a fourth time, the FADEC aborts the start.

UG913131 - U7RT0EC - UM74D2CFM000002



EXHAUST GAS TEMPERATURE OVERLIMIT OR STALL FAULT IN AUTOMATIC MODE - FIRST ATTEMPT ... FOURTH ATTEMPT



EXHAUST GAS TEMPERATURE OVERLIMIT OR STALL FAULT IN AUTOMATIC MODE - FIRST ATTEMPT ... FOURTH ATTEMPT

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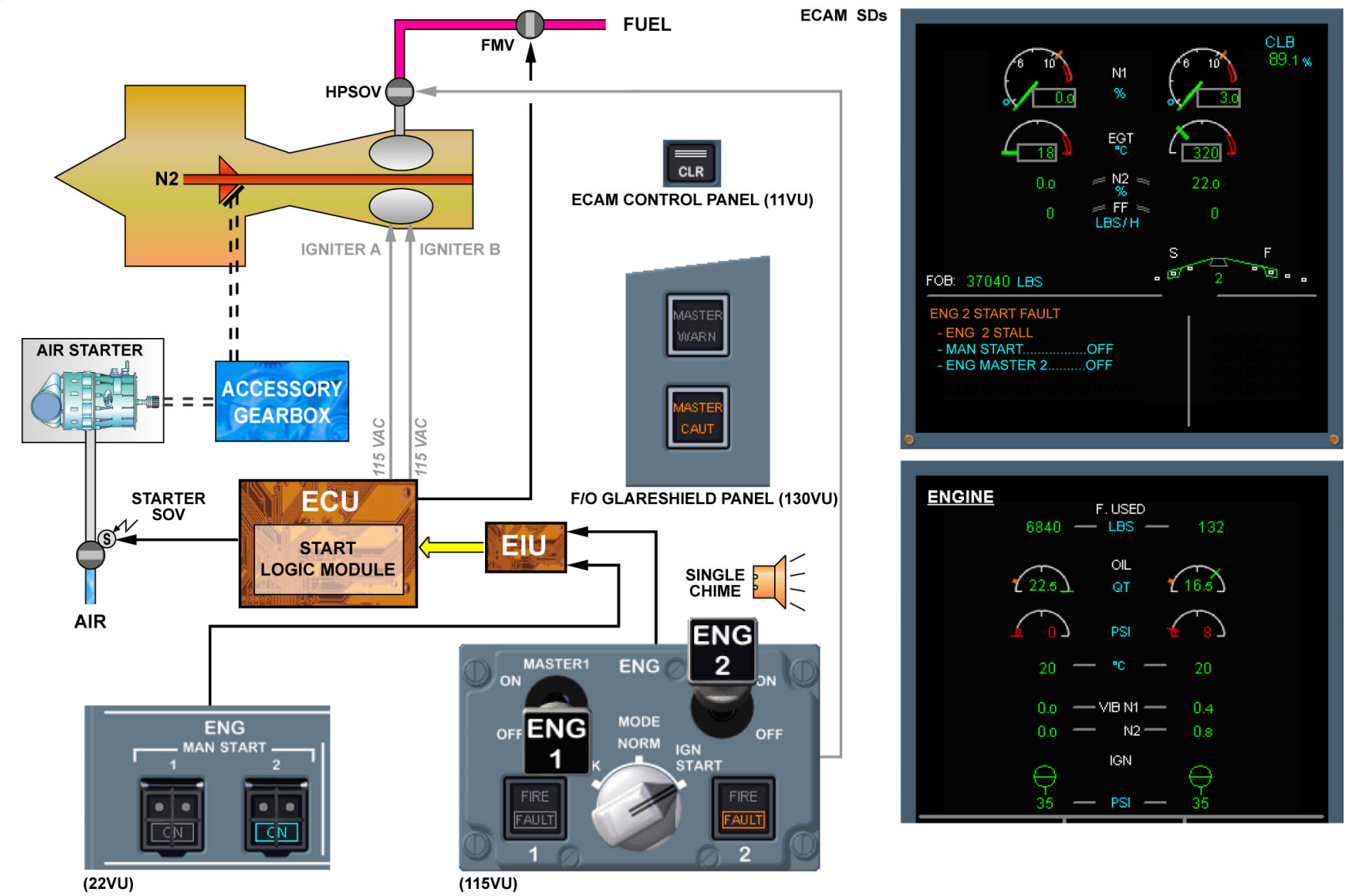
UG913131 - U7RT0EC - UM74D2CFM000002

START FAILURES (US) (3)

EXHAUST GAS TEMPERATURE OVERLIMIT OR STALL FAULT IN MANUAL MODE

When a stall or an EGT overlimit is detected, an aural warning sounds, the MASTER CAUTion and the engine FAULT lights come on and an ECAM message appears.
In the shown case, the FADEC has detected an engine stall. If no corrective action is taken by the crew, the FADEC will abort the start following an overlimit detection.



EXHAUST GAS TEMPERATURE OVERLIMIT OR STALL FAULT IN MANUAL MODE

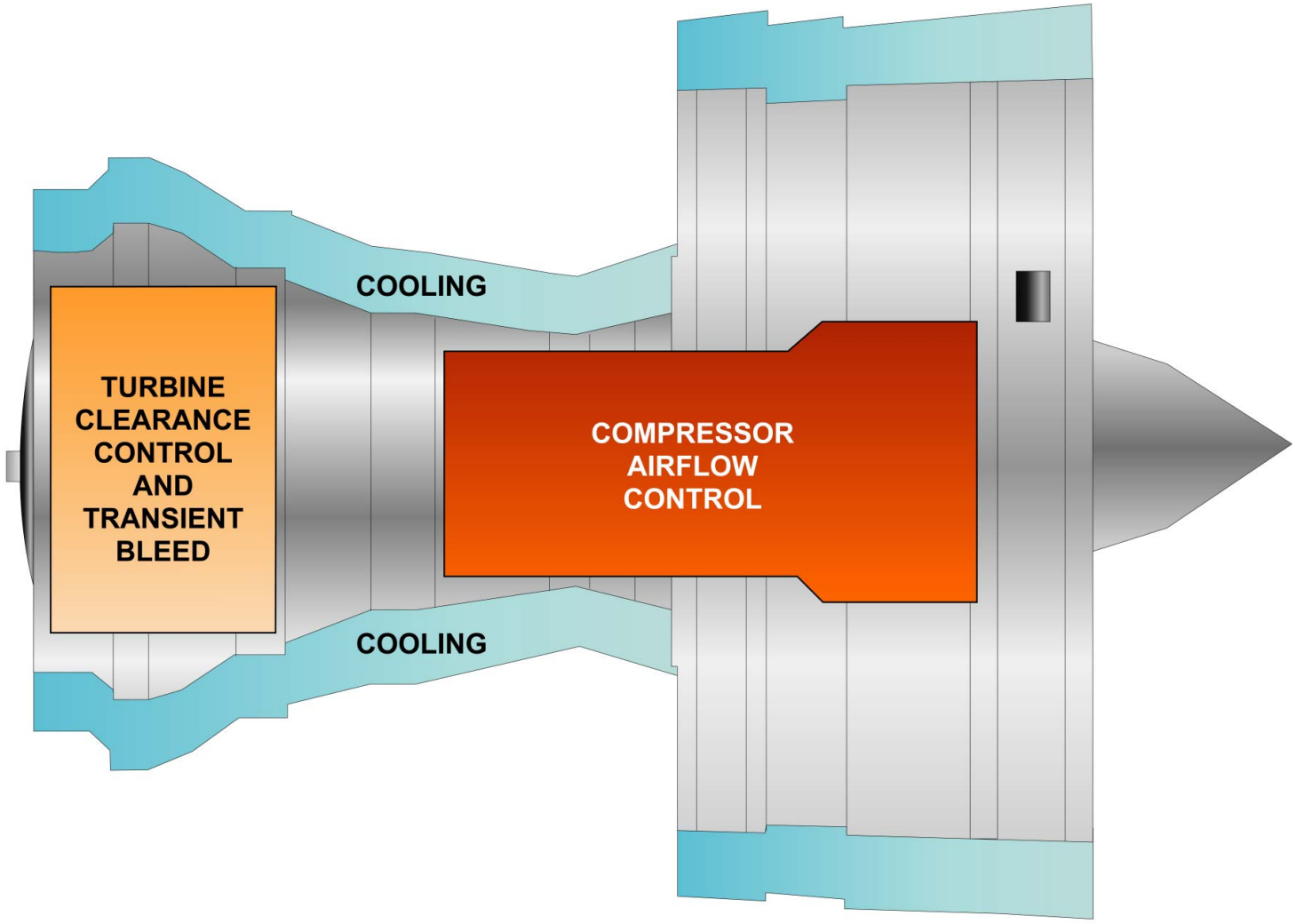
UG913131 - U7RT0EC - UM74D2CFM000002

AIR SYSTEM DESCRIPTION/OPERATION (3)

GENERAL

The engine air system covers the compressor airflow control, turbine clearance control, transient bleed and cooling.

UG913131 - U7RT0EC - UM75P1CFM000001


COOLING
TURBINE CLEARANCE CONTROL AND TRANSIENT BLEED
COMPRESSOR AIRFLOW CONTROL
COOLING

GENERAL

AIR SYSTEM DESCRIPTION/OPERATION (3)

COMPRESSOR AIRFLOW CONTROL

To prevent compressor surge and to give a good acceleration, the engine has a Variable Bleed Valve (VBV) system and a Variable Stator Vane (VSV) system.
Both systems are fuel operated by the HydroMechanical Unit (HMU) and controlled by the Electronic Control Unit (ECU).

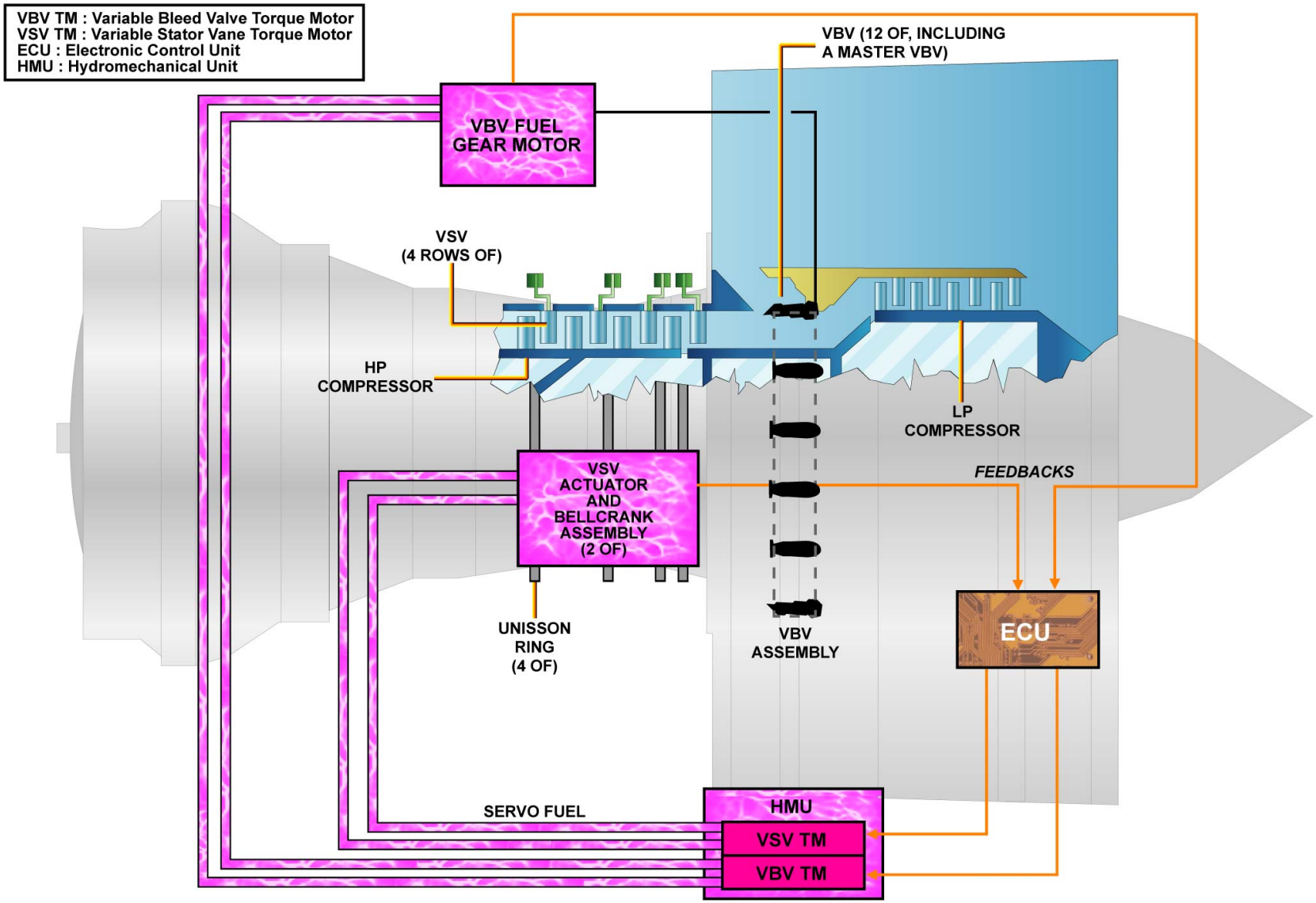
VARIABLE BLEED VALVE SYSTEM

The VBV system controls the airflow from the fan and the booster to the High Pressure Compressor (HPC) by using 12 valves. By dumping excessive air into the fan air stream, the VBVs increase the booster mass flow and improve the booster and the HPC matching at low speed and transient operations.

VARIABLE STATOR VANE SYSTEM

The VSV system controls the primary airflow through the HPC by varying the angle of the Inlet Guide Vanes (IGVs) and three stages of variable vanes. The VSVs give aerodynamic matching of the LP stages of compression with the HP stages to prevent engine surge.

UG913131 - U7RT0EC - UM75P1CFM000001



COMPRESSOR AIRFLOW CONTROL - VARIABLE BLEED VALVE SYSTEM & VARIABLE STATOR VANE SYSTEM

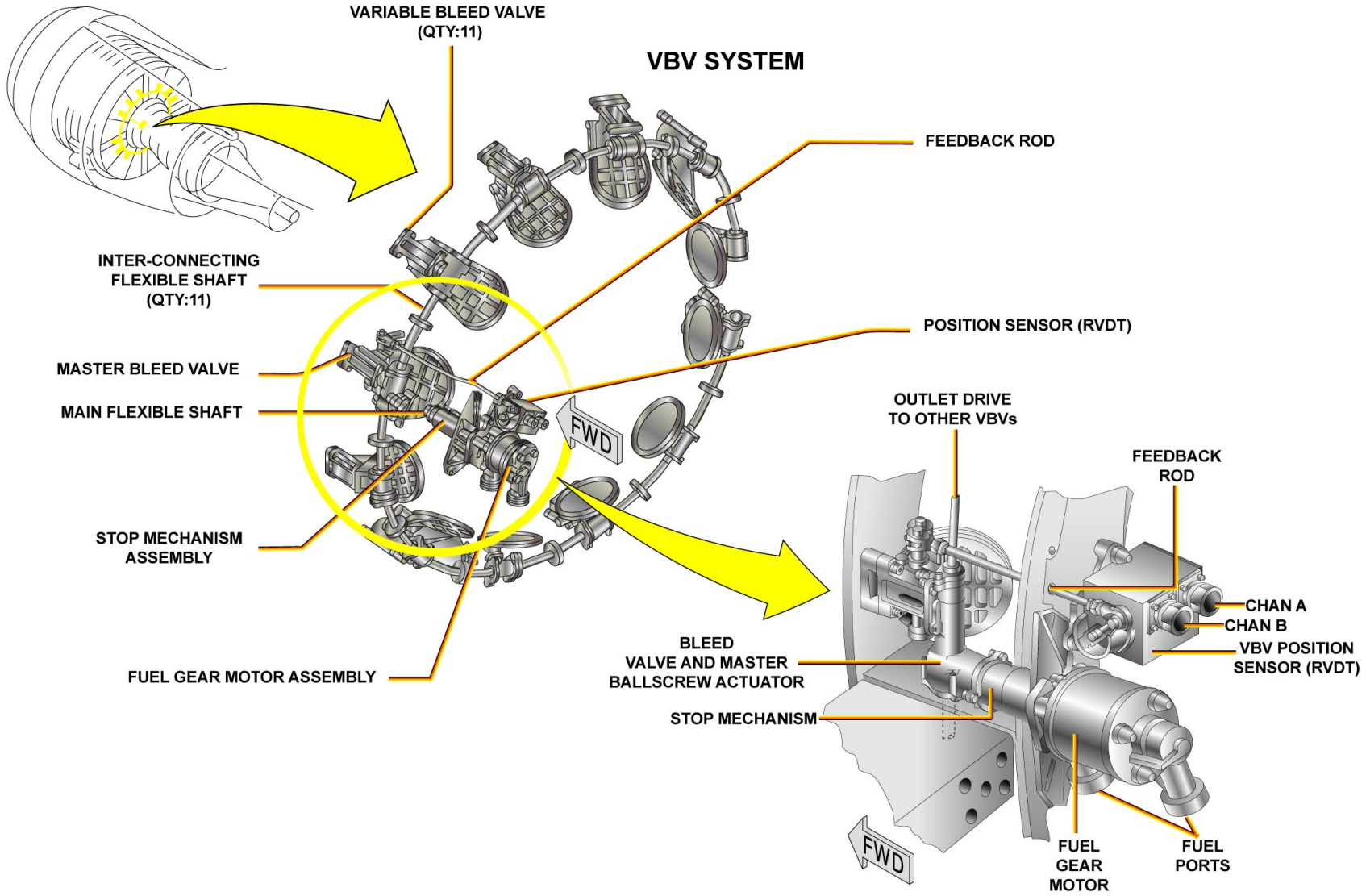
UG913131 - U7RT0EC - UM75P1CFM000001

AIR SYSTEM DESCRIPTION/OPERATION (3)

VBV SYSTEM DESCRIPTION

The function of the Variable Bleed Valve (VBV) system is to regulate the amount of air discharged from the booster into the inlet of the HPC. To eliminate the risk of booster stall during low power conditions, the VBV system by-passes air from the primary airflow into the secondary airflow.
It is installed within the fan frame mid-box structure and is composed of:
-A fuel gear motor
-A stop mechanism
-A master bleed valve
-Eleven variable bleed valves
-Flexible shafts
-A feedback sensor (RVDT)
The ECU calculates the VBV position and the HMU gives the necessary fuel pressure to drive a fuel gear motor, through a dedicated servo valve.

UG913131 - U7RT0EC - UM75P1CFM000001



VBV SYSTEM DESCRIPTION

AIR SYSTEM DESCRIPTION/OPERATION (3)

VBV OPERATION

FUEL GEAR MOTOR

The fuel gear motor transforms high pressure fuel flow into rotary driving power to position the master bleed valve, through a screw in the stop mechanism.
The fuel flow sent to the gear motor is constantly controlled by the ECU, via the torque motor and servo valve in the HMU.

STOP MECHANISM

The stop mechanism limits the number of revolutions of the gear motor to the exact number, required for a complete cycle (open and close) of the VBV system.
The stop mechanism is located in between the gear motor and the master ball screw actuator.

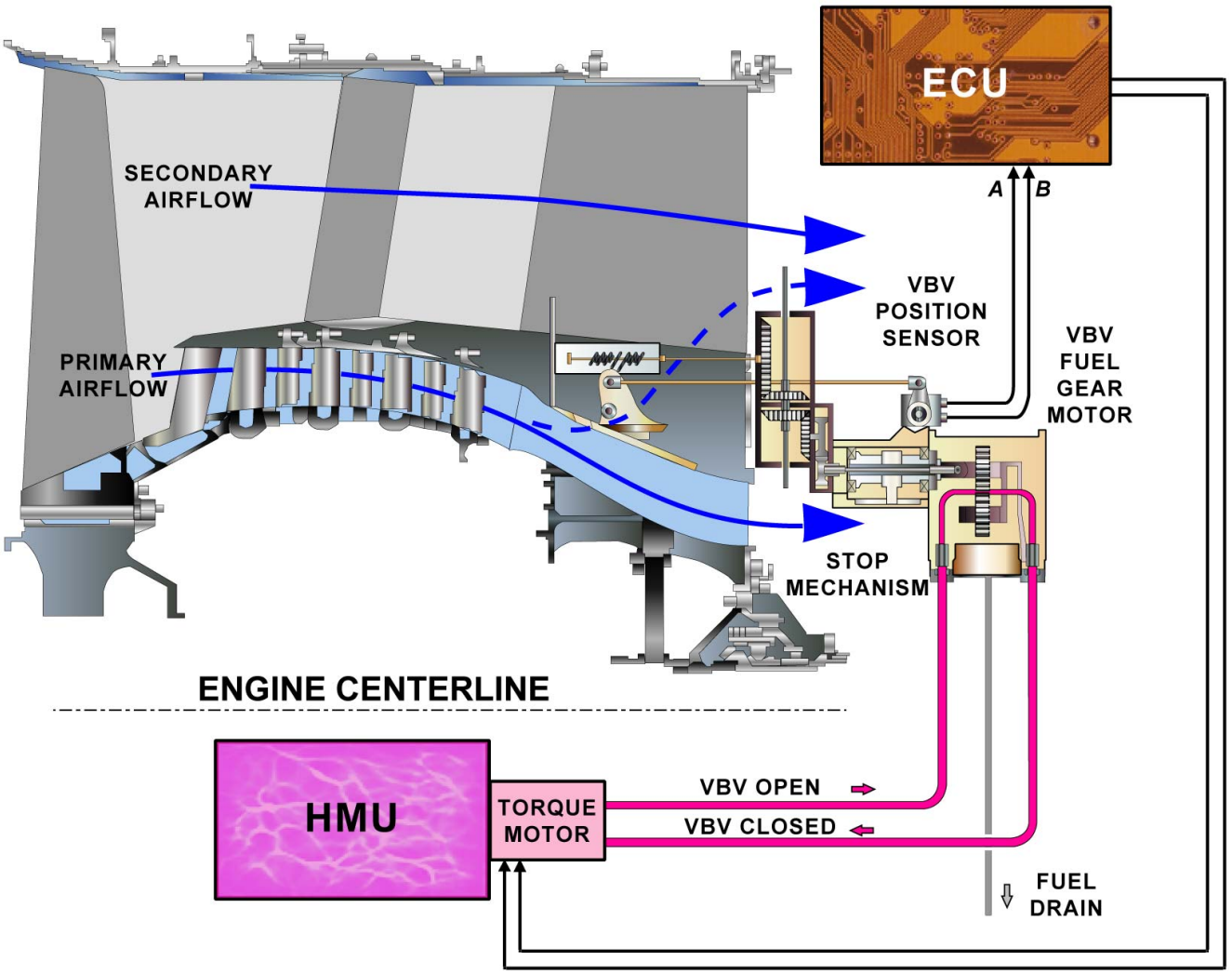
MASTER BLEED VALVE and FEEDBACK SENSOR

The master bleed valve and ballscrew actuator assembly is a unit, which transmits the driving input from the gear motor to the 11 remaining variable bleed valves (VBV's).
A lever, integral with a hinged door, is connected to a feedback rod, which transmits the angular position of the door to an RVDT. This sensor gives the position feedback to the ECU.
It has two marks, which should be aligned when the system is adjusted to the fully closed position. The adjustment is done through the feedback rod in between the master bleed valve and the RVDT.

VARIABLE BLEED VALVES (VBV's)

The master bleed valve drives the 11 variable bleeds valves (VBVs) through a series of flexible shafts. The flexible shafts make sure that the VBVs remain fully synchronized throughout their complete operation.

UG913131 - U7RT0EC - UM75P1CFM000001



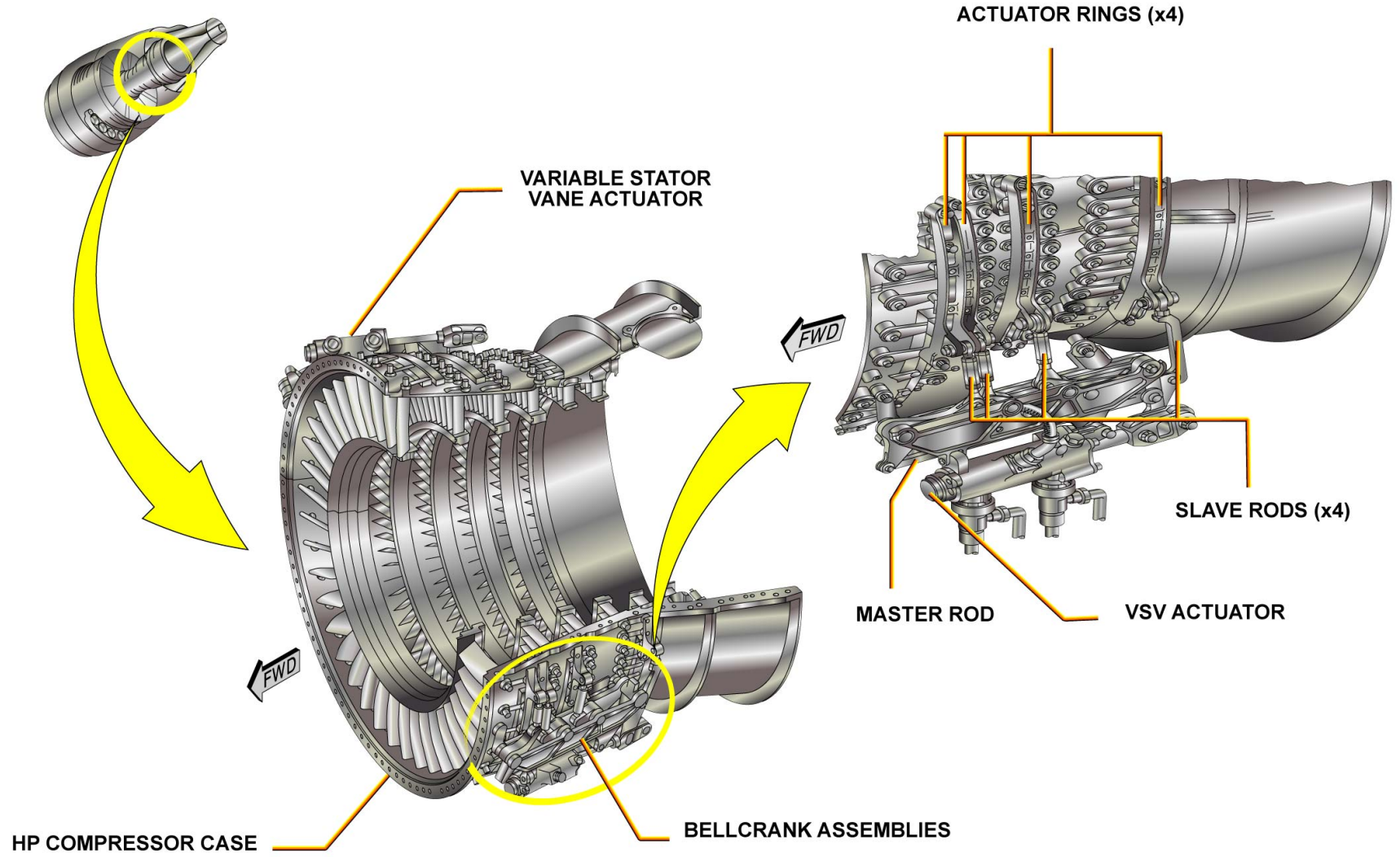
VBV OPERATION - FUEL GEAR MOTOR ... VARIABLE BLEED VALVES (VBV'S)

AIR SYSTEM DESCRIPTION/OPERATION (3)

VSV SYSTEM DESCRIPTION

The Variable Stator Vane (VSV) system positions the HPC stator vanes to the appropriate angle to optimize HPC efficiency. It also improves the stall margin during transient engine operations. The VSV position is calculated by the ECU using various engine parameters, and the necessary fuel pressure is delivered by the HMU dedicated servo valve. The VSV system is located at the front of the HP compressor.
The VSV system is composed of:
A series of actuators and bellcrank assemblies
Two hydraulic actuators
Two feedback sensors (in actuators)
Two bellcrank assemblies
Four actuation rings
Variable stator stages (inside HPC case)
Inlet Guide Vanes (IGVs)
Variable Stator Vanes (VSVs)

UG913131 - U7RT0EC - UM75P1CFM000001



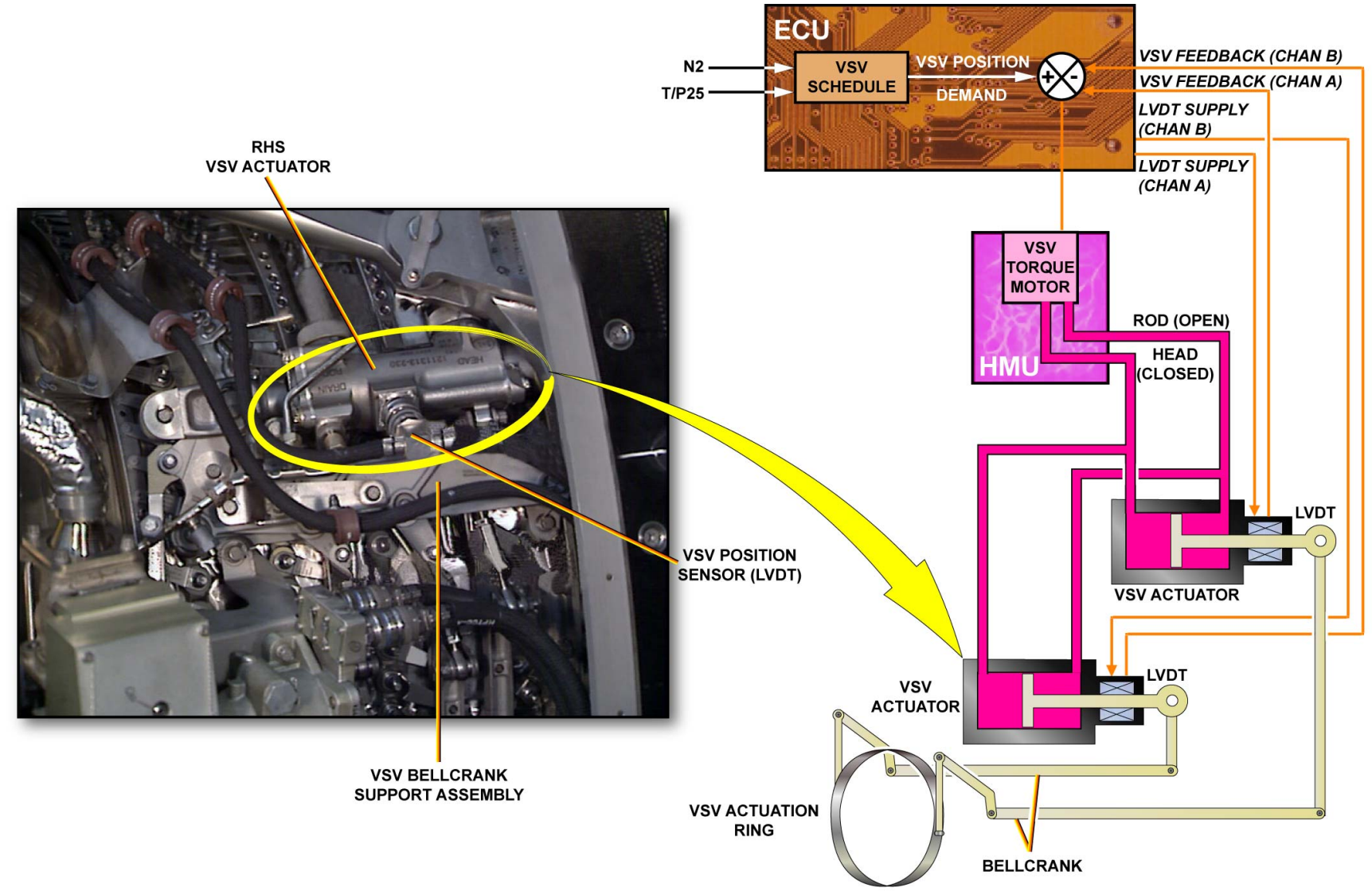
VSV SYSTEM DESCRIPTION

AIR SYSTEM DESCRIPTION/OPERATION (3)

VSV SYSTEM OPERATION

The VSV system positions the compressor VSVs to the angles necessary to give the optimum compressor efficiency and stall margin for transient engine operation. Stator vane angle is a function of core engine speed (N2) and altitude.
The VSV actuator drives the VSV linkage assembly to the stator angle calculated by the ECU, through the HMU. The torque motor supplies fuel to the actuator to close or open the vanes or hold their position by pressure balancing the actuator piston. The LVDT transmits a feedback signal of actual vane position to the ECU for comparison to scheduled position.

UG913131 - U7RT0EC - UM75P1CFM000001



VSV SYSTEM OPERATION

AIR SYSTEM DESCRIPTION/OPERATION (3)

ACTIVE CLEARANCE CONTROL AND TRANSIENT BLEED

There are three systems independently controlled by the ECU and actuated from the HMU, which give to the engine clearance adjustment and transient bleed.
The clearance between the blade tips and the casings is actively controlled in order to optimize engine performance using cooling air to shrink the LP and HP turbine casings.

HIGH PRESSURE TURBINE ACTIVE CLEARANCE CONTROL

The High Pressure Turbine Active Clearance Control (HPTACC) system uses stage 4 and stage 9 HPC air to heat or cool the High Pressure Turbine (HPT) shroud support structure.
The ECU monitors the shroud support structure temperature using the T case sensor.

LOW PRESSURE ACTIVE CLEARANCE CONTROL SYSTEM

The Low Pressure Turbine Active Clearance Control (LPTACC) system uses fan air for external case cooling of the Low Pressure Turbine (LPT).

SYSTEM TRANSIENT BLEED VALVE SYSTEM

The Transient Bleed Valve (TBV) improves the compressor stall margin during transient and start conditions. The TBV unloads the HPC by discharging stage 9 HPC air in the LPT cavity.

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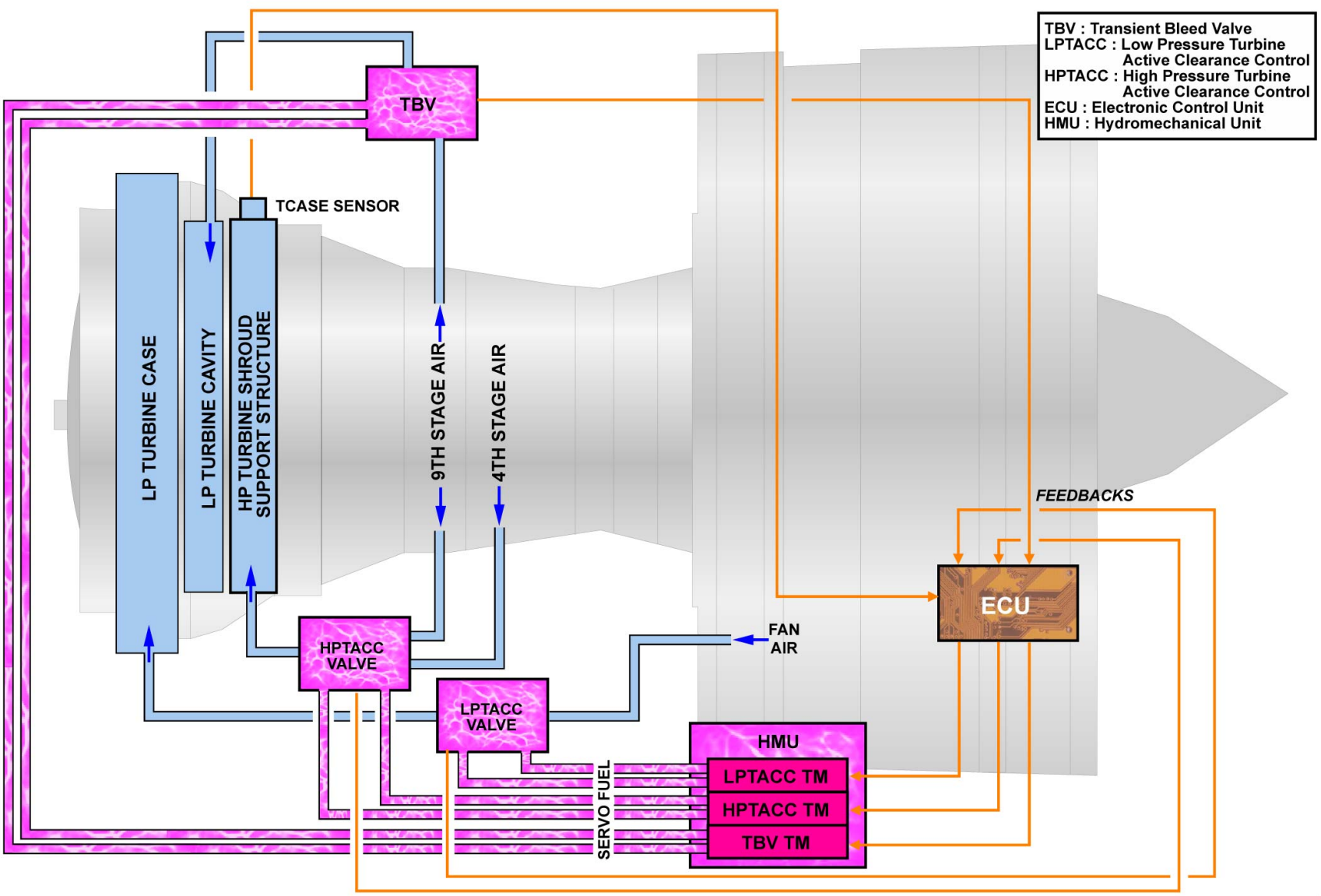


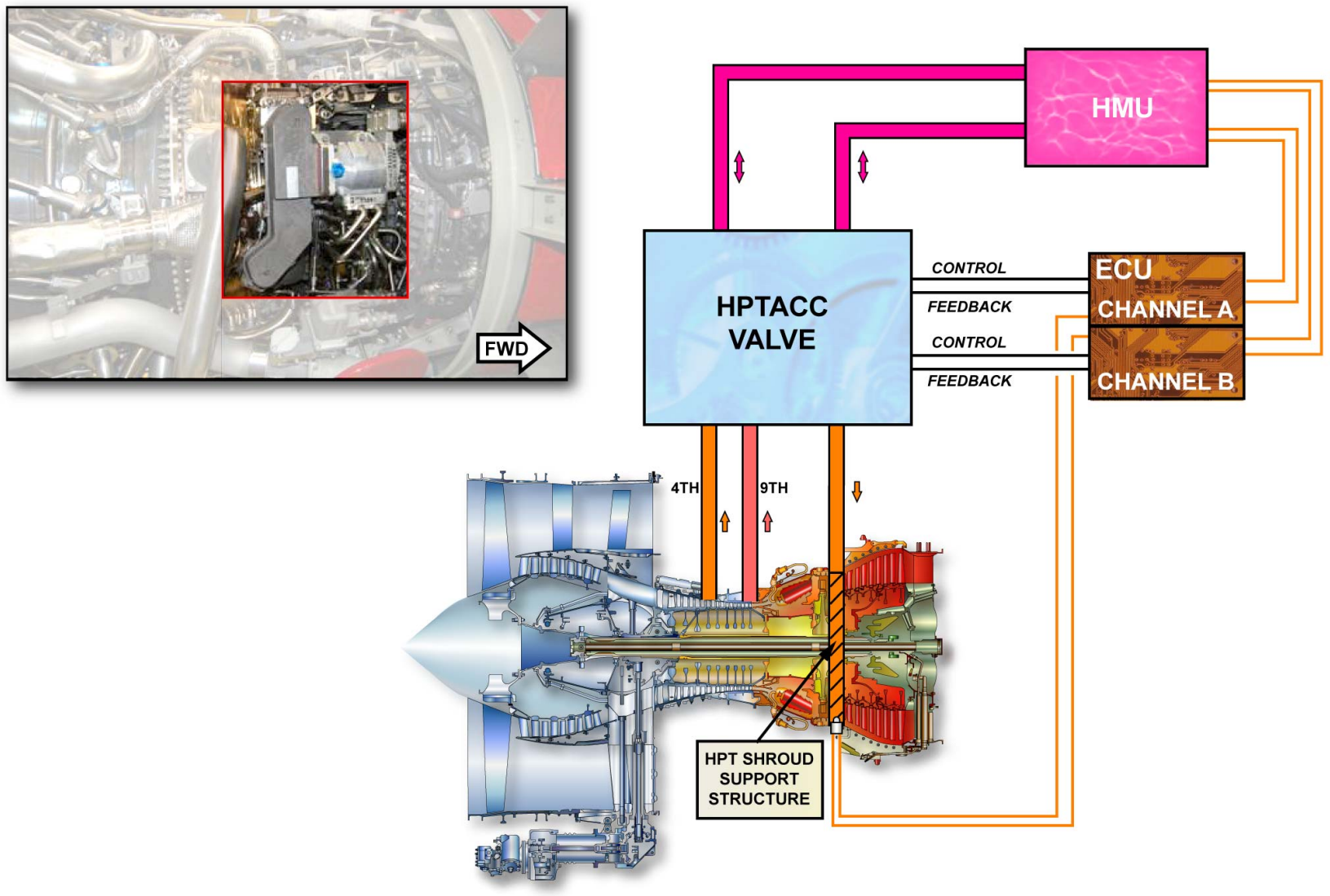
ACTIVE CLEARANCE CONTROL AND TRANSIENT BLEED - HIGH PRESSURE TURBINE ACTIVE CLEARANCE CONTROL ... SYSTEM TRANSIENT BLEED VALVE SYSTEM

AIR SYSTEM DESCRIPTION/OPERATION (3)

HIGH PRESSURE TURBINE CLEARANCE CONTROL (HPTCC)

The HPTACC system optimizes HPT efficiency through active clearance control between the turbine rotor and shroud and reduces compressor load during starting and transient engine conditions. The HPTACC valve is located on the engine core section. This system is a closed loop system, using valve position status as feedback.

UG913131 - U7RT0EC - UM75P1CFM000001



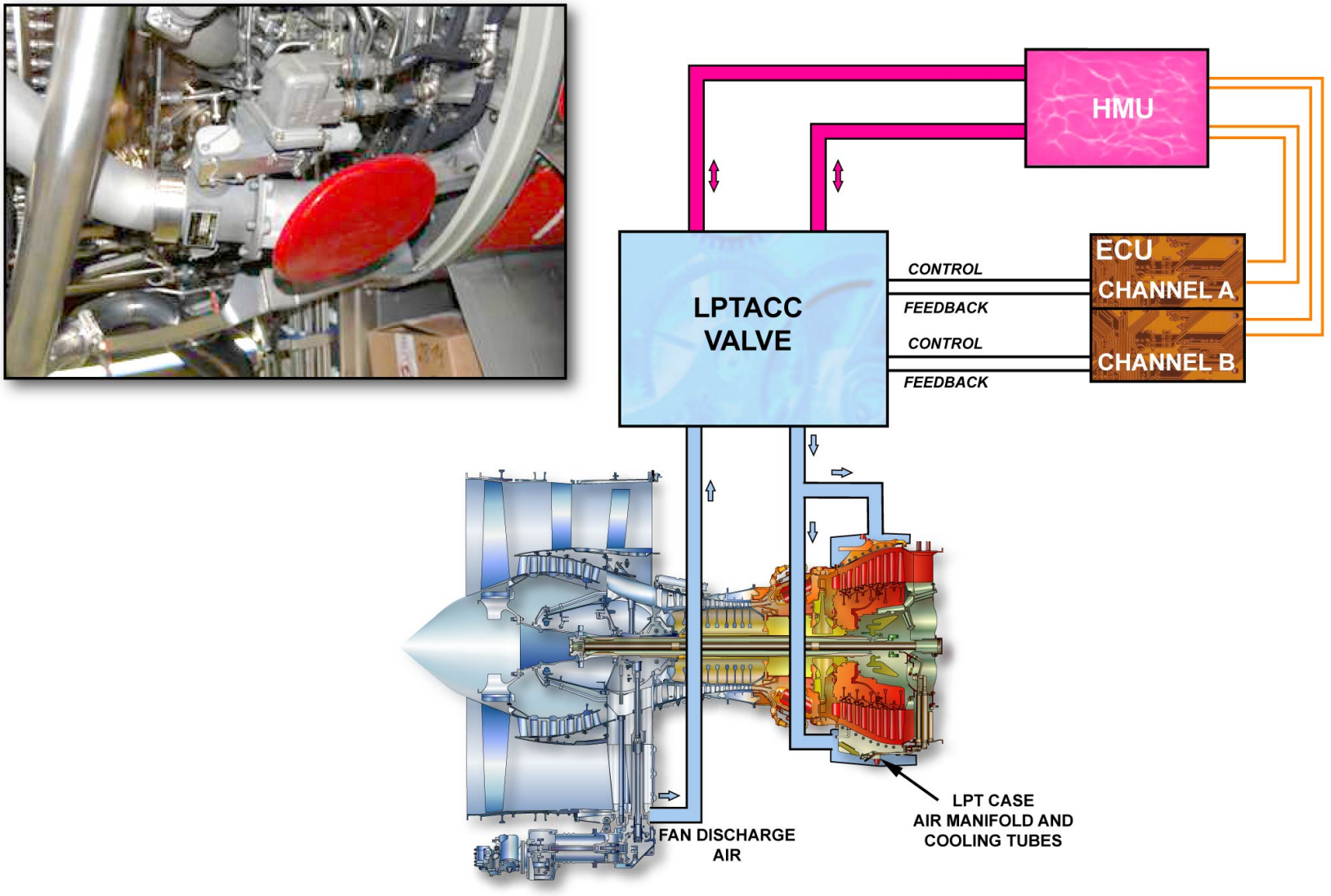
HIGH PRESSURE TURBINE CLEARANCE CONTROL (HPTCC)

AIR SYSTEM DESCRIPTION/OPERATION (3)

LOW PRESSURE TURBINE CLEARANCE CONTROL (LPTCC)

The Low Pressure Turbine Clearance Control (LPTCC) system uses fan discharge air to cool the LPT case during engine operation, in order to control the LPT rotor to stator clearances. It also protects the turbine case from over-temperature by monitoring the EGT.
This ensures the best performance of the LPT at all engine ratings.
The LPTCC system is a closed loop system, which regulates the cooling airflow sent to the LPT case, through a valve and a manifold.
A dual RVDT sensor is installed at one end of the butterfly valve shaft and supplies the feedback signal to the ECU.

UG913131 - U7RT0EC - UM75P1CFM000001



LOW PRESSURE TURBINE CLEARANCE CONTROL (LPTCC)

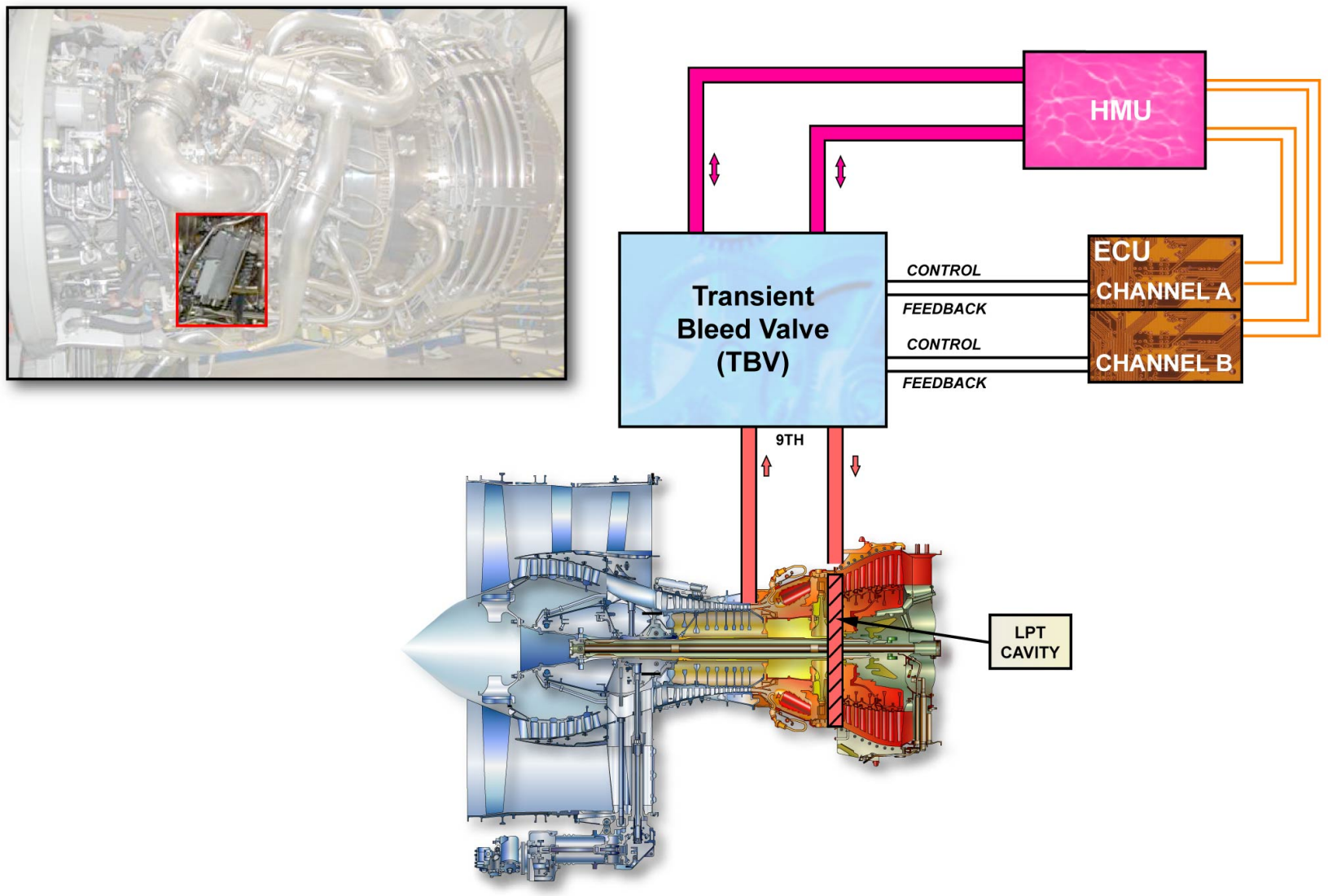
AIR SYSTEM DESCRIPTION/OPERATION (3)

TRANSIENT BLEED VALVE (TBV)

The Transient Bleed Valve (TBV) system improves the HPC stall margin during engine starting and rapid transient acceleration.
Using engine input parameters, the ECU logic calculates when to open or close the TBV to duct HPC 9th stage bleed air, in order to give optimum stability for transient mode operations.

The 9th stage bleed air is ducted to the LPT stage 1 nozzle, providing an efficient start stall margin.
The ECU, working through the HMU, controls the TBV position.
The TBV system consists of:
- The TBV, located on the HPC case, between the 7 and 8 o'clock positions.
- The 9th stage air IN and OUT pipes.

The valve position is monitored by the ECU, through a dual channel LVDT. The LVDT supplies the feedback signal, which agrees with the butterfly position.



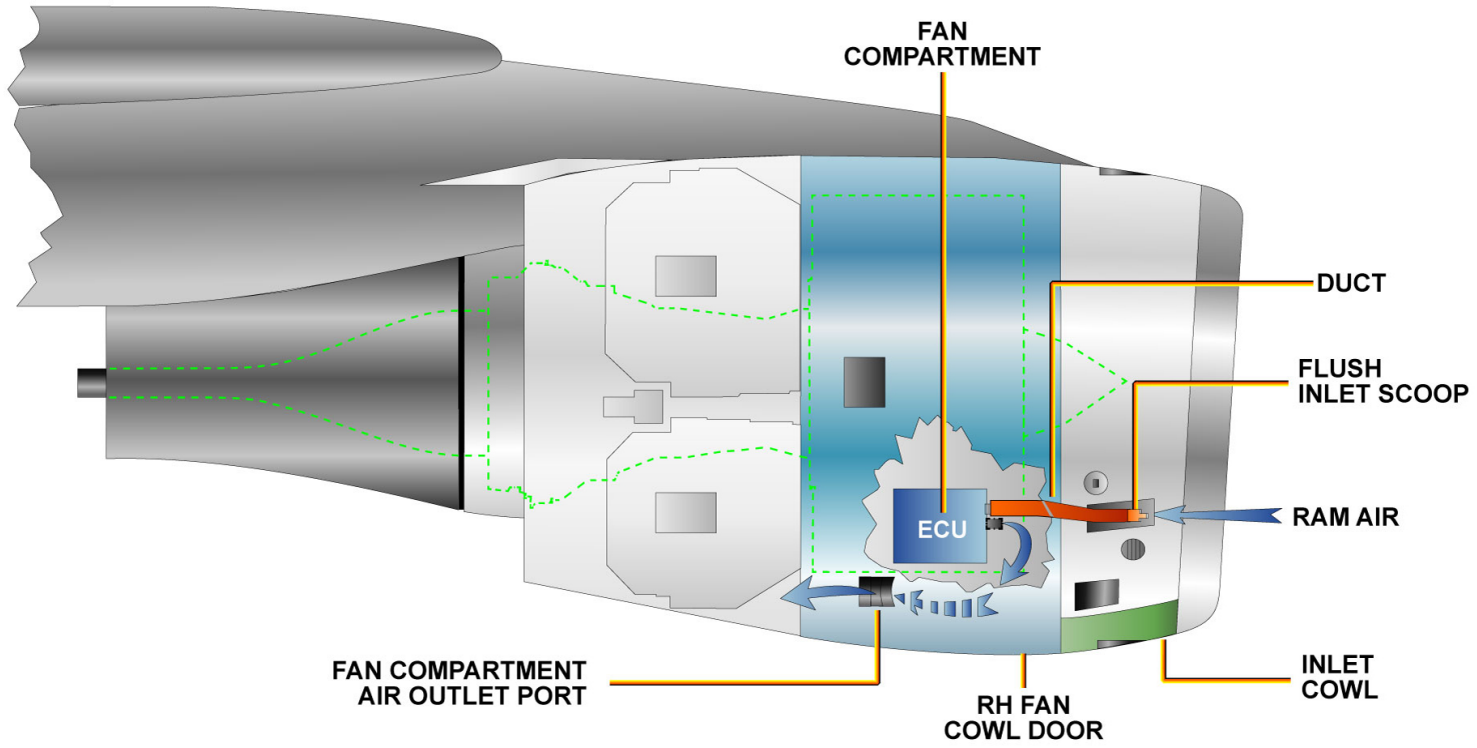
TRANSIENT BLEED VALVE (TBV)

AIR SYSTEM DESCRIPTION/OPERATION (3)

ELECTRONIC CONTROL UNIT COOLING

The ECU is aerodynamically cooled to maintain its internal temperature below maximum limits.
A flush inlet scoop, located on the inlet cowl outer barrel, supplies ram air through a duct to the ECU. This air is then discharged into the fan compartment ventilation zone.

UG913131 - U7RT0EC - UM75P1CFM000001



ELECTRONIC CONTROL UNIT COOLING

AIR SYSTEM DESCRIPTION/OPERATION (3)

NACELLE COOLING

The fan and core compartments, which form the nacelle, are cooled by airflows around the engine during its operation.

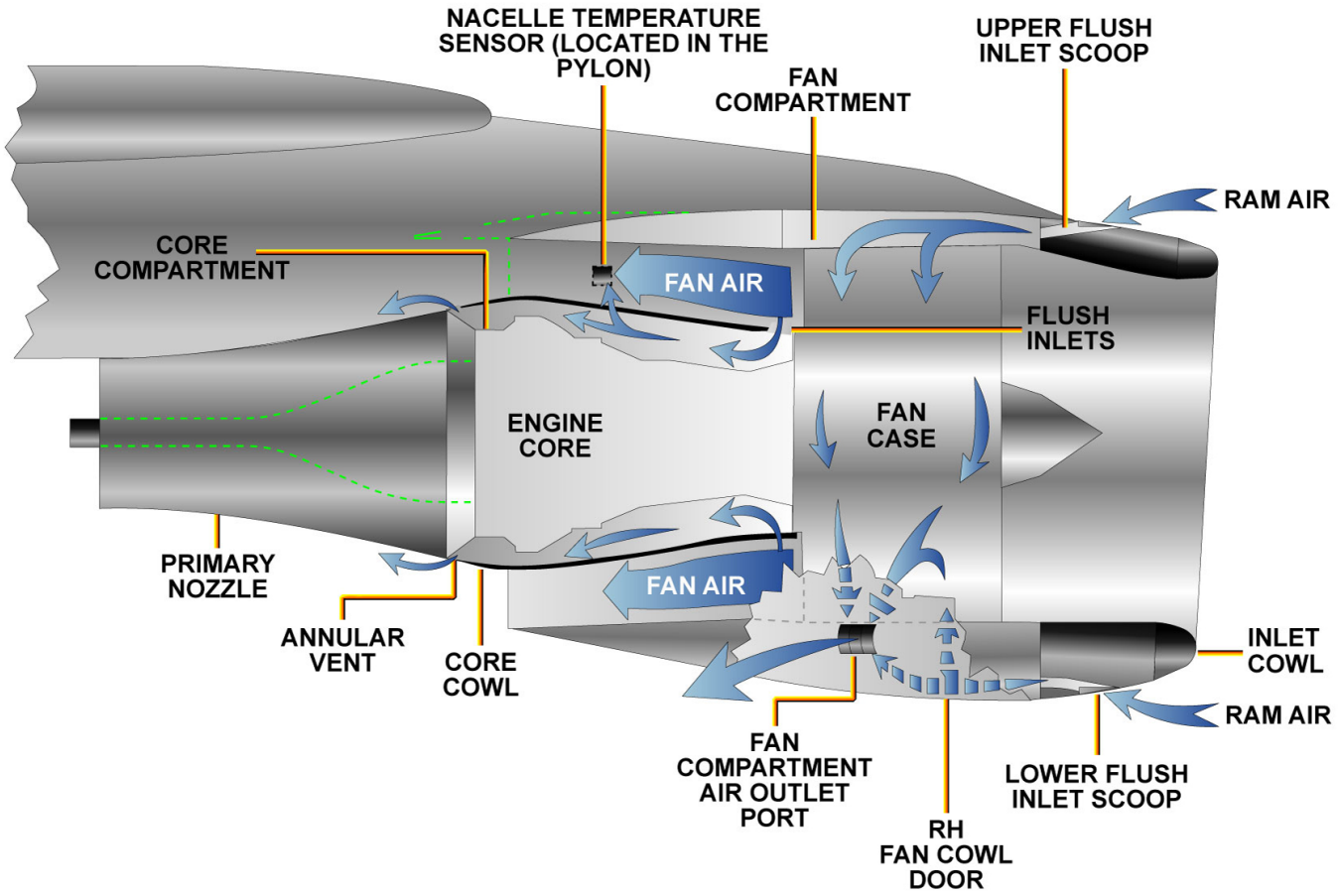
FAN COMPARTMENT

The fan case and accessories are cooled and ventilated by air entering two flush inlet scoops located on the inlet cowl outer barrel.
Then the air exits the fan compartment through an outlet port located in the lower aft section of the right hand fan cowl door.

CORE COMPARTMENT

The core compartment is cooled and ventilated by fan air entering flush inlets located at the forward section of the core cowl.
Then the air exits the core compartment through the annular vent located at the interface between the core cowl and the primary nozzle.
A nacelle temperature sensor monitors the core compartment temperature.

UG913131 - U7RT0EC - UM75P1CFM000001



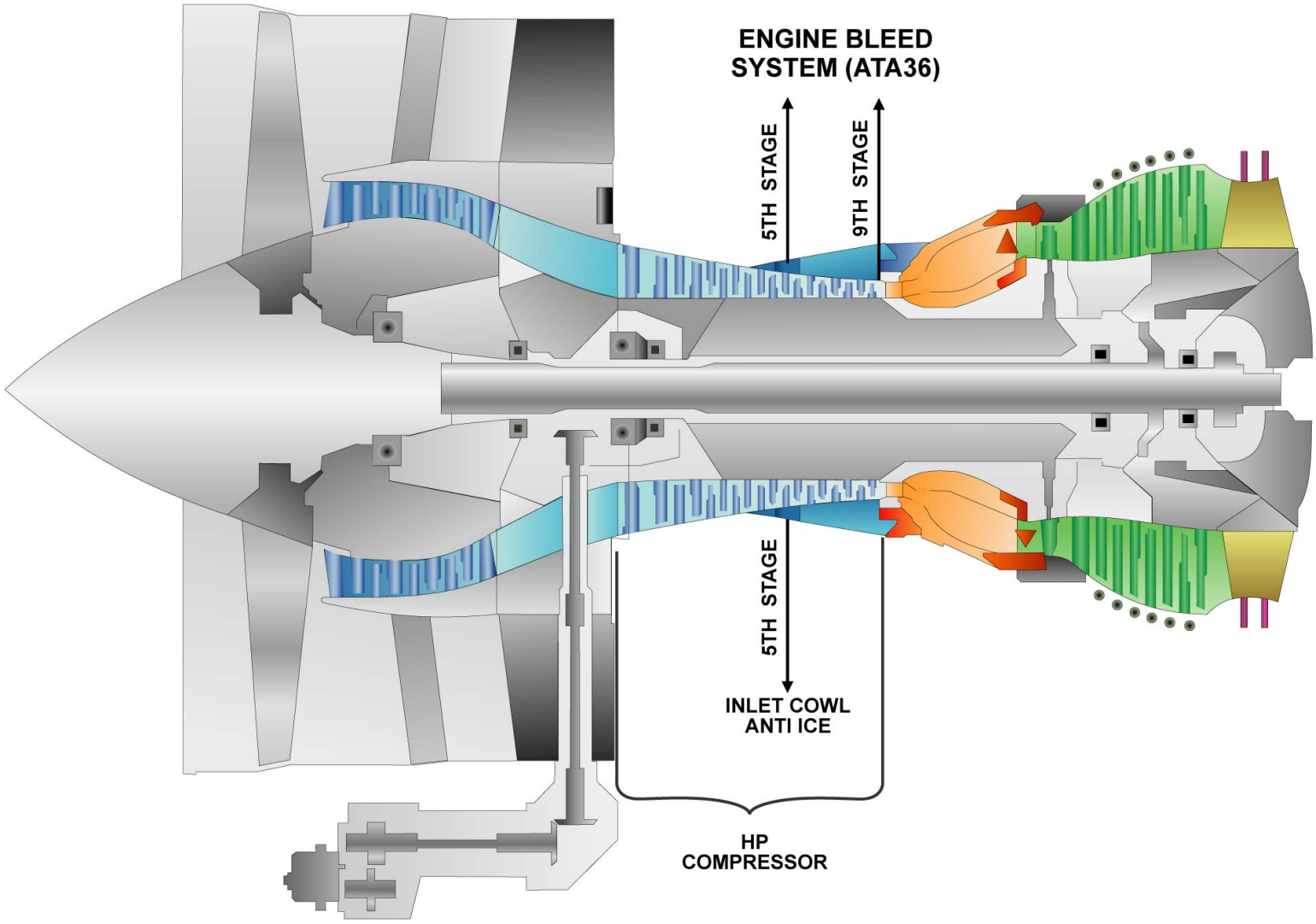
NACELLE COOLING - FAN COMPARTMENT & CORE COMPARTMENT

AIR SYSTEM DESCRIPTION/OPERATION (3)

PNEUMATIC SOURCES

The engine gives sources to feed the Active Clearance Control subsystems and also to supply the inlet cowl anti-ice (5th compressor stage) and the engine bleed system (5th and 9th compressor stages).

UG913131 - U7RT0EC - UM75P1CFM000001



PNEUMATIC SOURCES

ENGINE THRUST MANAGEMENT (3)

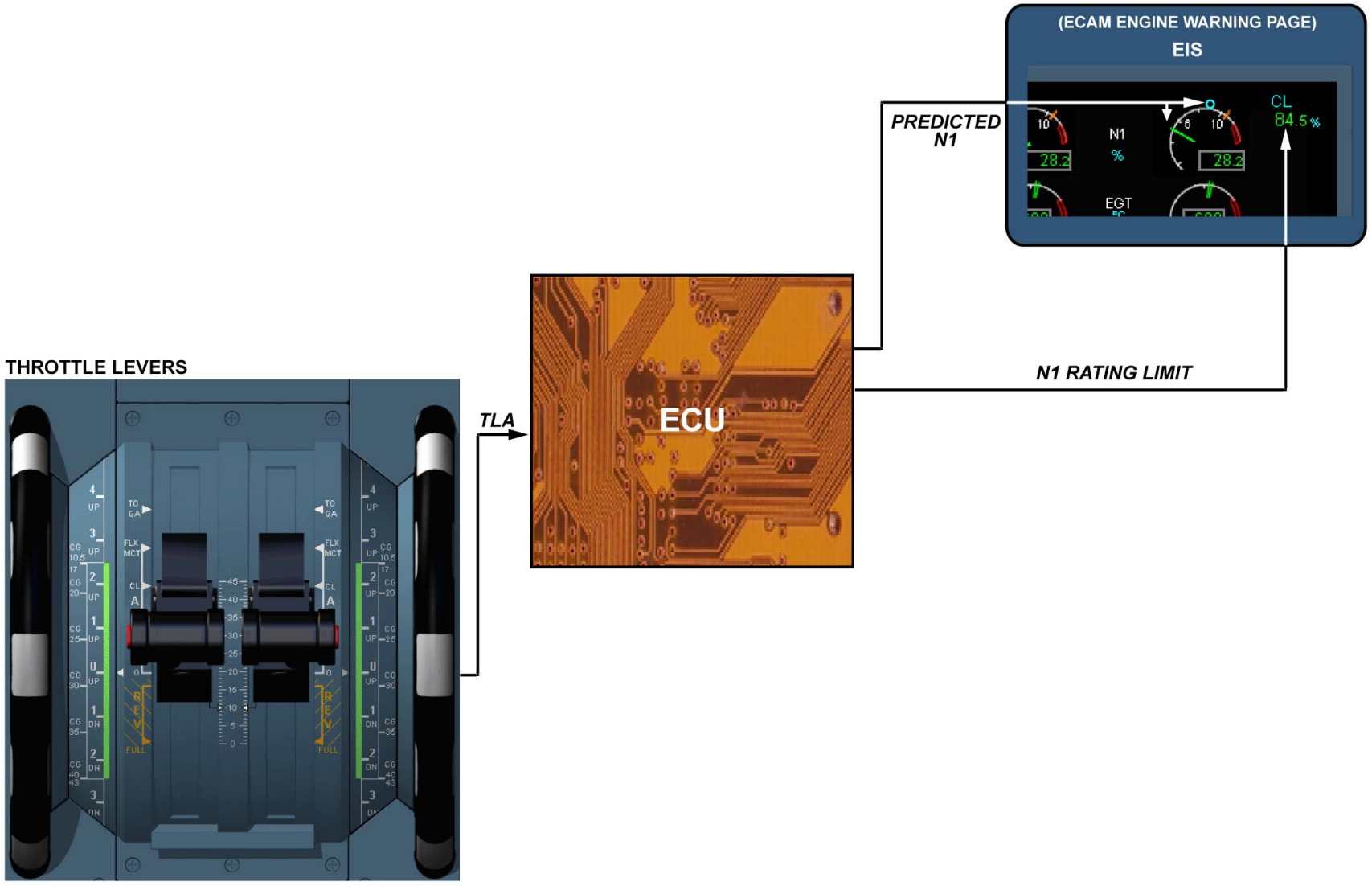
BASIC INFORMATION

Some basic information about Engine Thrust Management is shown in this module.

PREDICTED N1

The predicted N1 is indicated by a blue circle on the N1 indicator and corresponds to the value determined by the Throttle Lever Angle (TLA).

UG913131 - U7RT0EC - UM76D1CFM000001



BASIC INFORMATION - PREDICTED N1

ENGINE THRUST MANAGEMENT (3)

BASIC INFORMATION (continued)

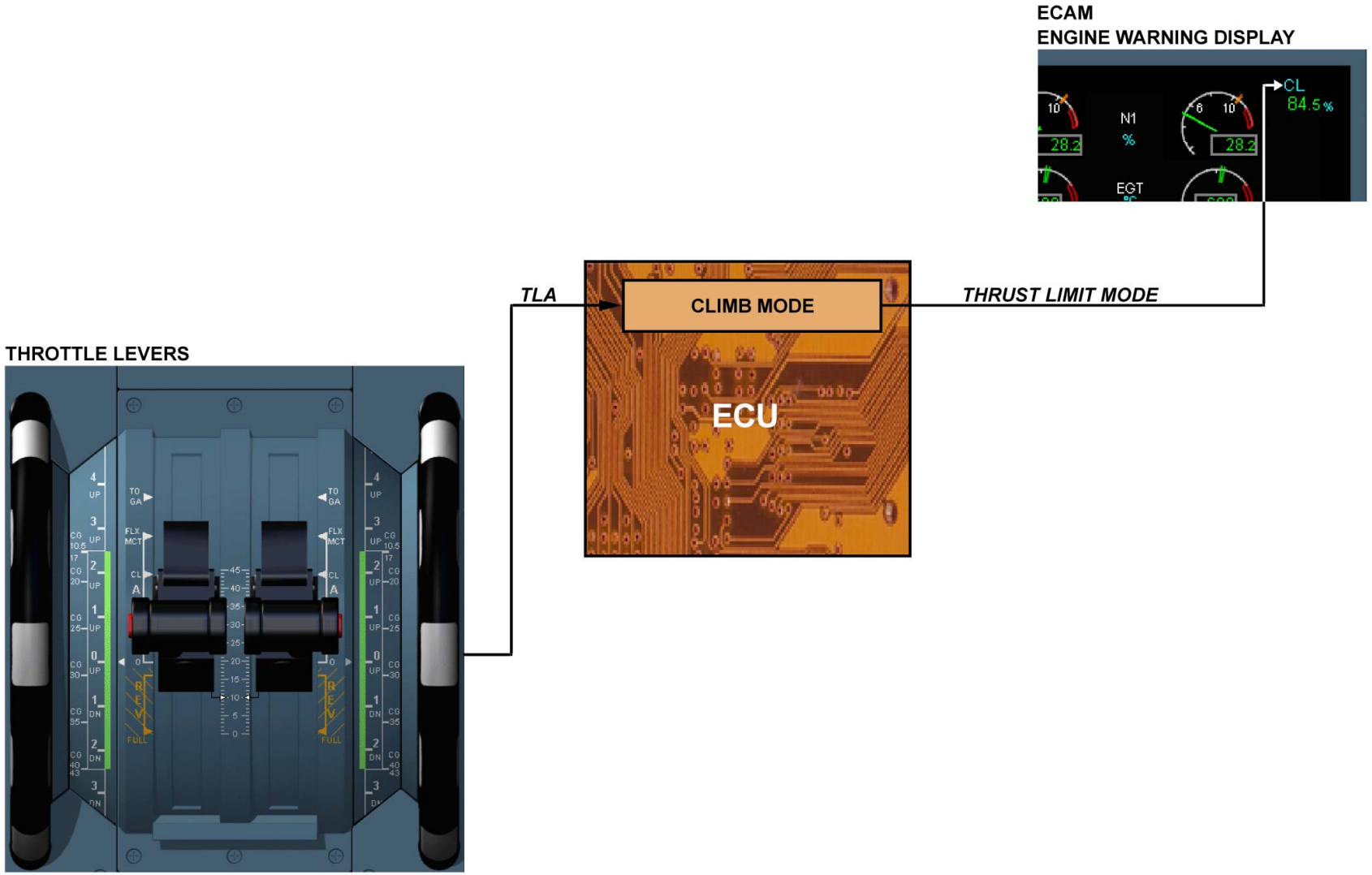
THRUST LIMIT MODE

The throttle levers are used as thrust limit mode selectors. Depending on the throttle lever position, a thrust limit mode is selected and appears on the upper ECAM display.
If the throttle levers are set between two detent points, the upper detent will determine the thrust limit mode.

NOTE: On the ground with the engines running the displayed N1 rate limit corresponds to the TO/GA thrust limit whatever the thrust lever position is.
On ground with engines running and if FLEX mode is selected, FLEX N1 is displayed whenever the thrust lever position is between IDLE and FLX/MCT.

The thrust limit modes are: Climb (CL), Flexible Take Off or Maximum Continuous Thrust (FLX/MCT), or Take Off Go Around (TOGA), Reverse mode limit (MREV).

UG913131 - U7RT0EC - UM76D1CFM000001



BASIC INFORMATION - THRUST LIMIT MODE

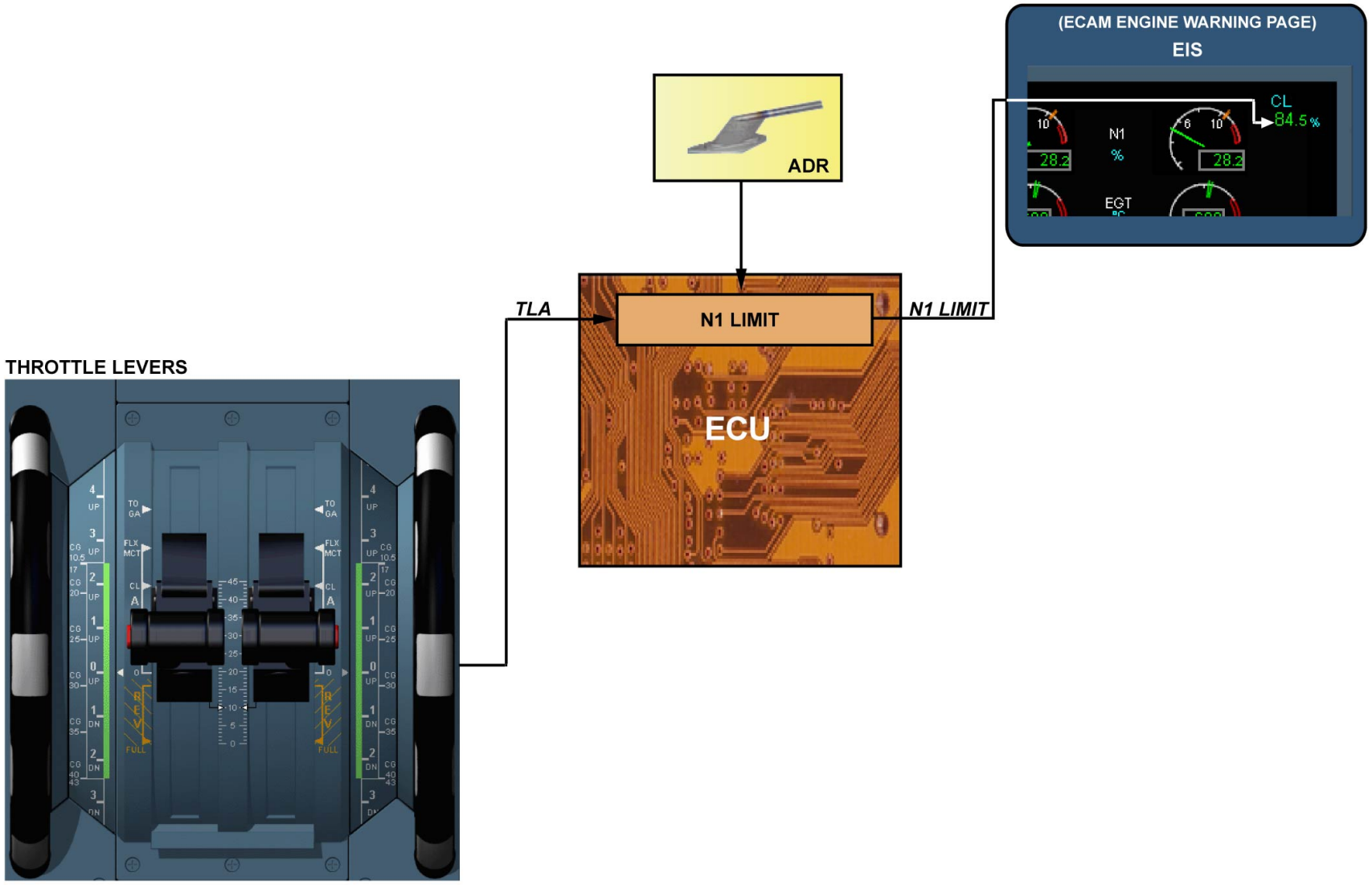
ENGINE THRUST MANAGEMENT (3)

BASIC INFORMATION (continued)

N1 LIMIT

For each thrust limit mode selection, an N1 rating limit is computed by the ECU according to Thrust Lever Angle (TLA) and the air data parameters from the Air Data Reference (ADR). This indication is displayed in green on the upper ECAM display near the thrust limit mode indication.

UG913131 - U7RT0EC - UM76D1CFM000001



BASIC INFORMATION - N1 LIMIT

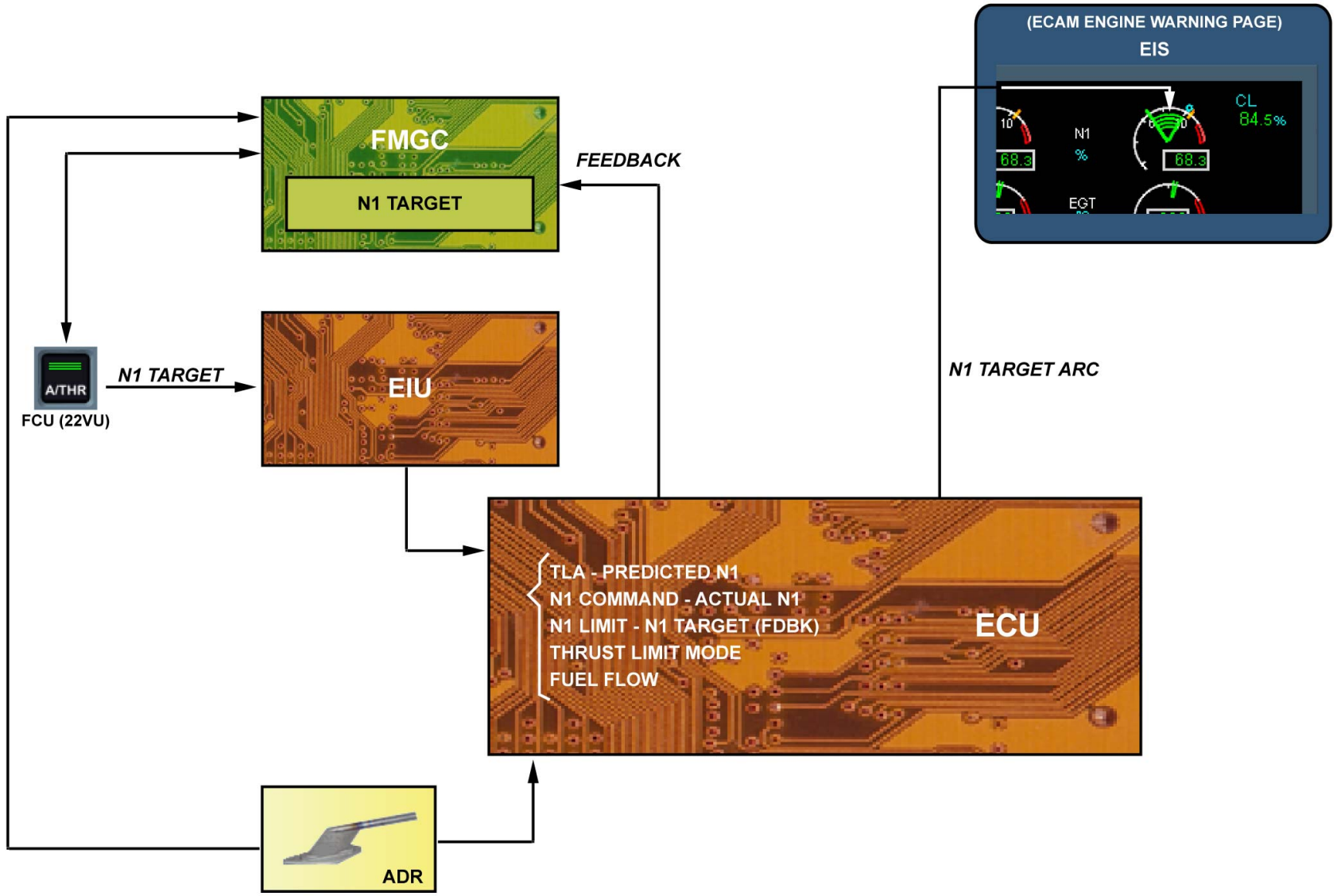
ENGINE THRUST MANAGEMENT (3)

BASIC INFORMATION (continued)

N1 TARGET

In Autothrust (A/THR) function, the Flight Management and Guidance System (FMGC) computes an N1 target according to air data and engine parameters and sends it to the Electronic Control Unit (ECU). Transient N1 (arc) symbolizes the difference between the N1 command and the actual N1. Not displayed if A/THR OFF.

UG913131 - U7RT0EC - UM76D1CFM000001



BASIC INFORMATION - N1 TARGET

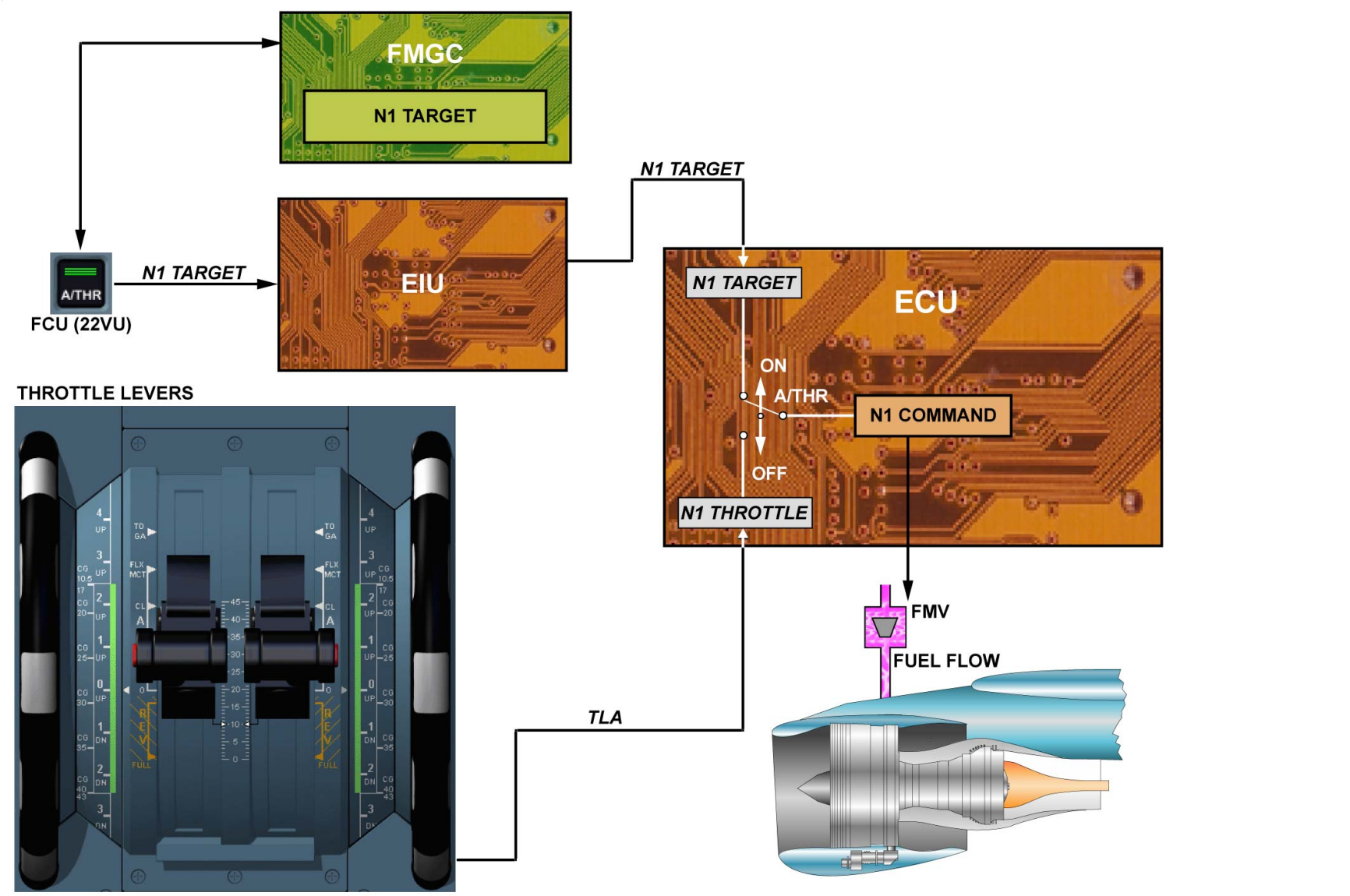
ENGINE THRUST MANAGEMENT (3)

BASIC INFORMATION (continued)

N1 COMMAND

The N1 command, used to regulate the fuel flow, is the FMGC N1 target when the A/THR function is active.
When the A/THR function is not active, the N1 command is the N1 corresponding to the TLA.

UG913131 - U7RT0EC - UM76D1CFM000001



BASIC INFORMATION - N1 COMMAND

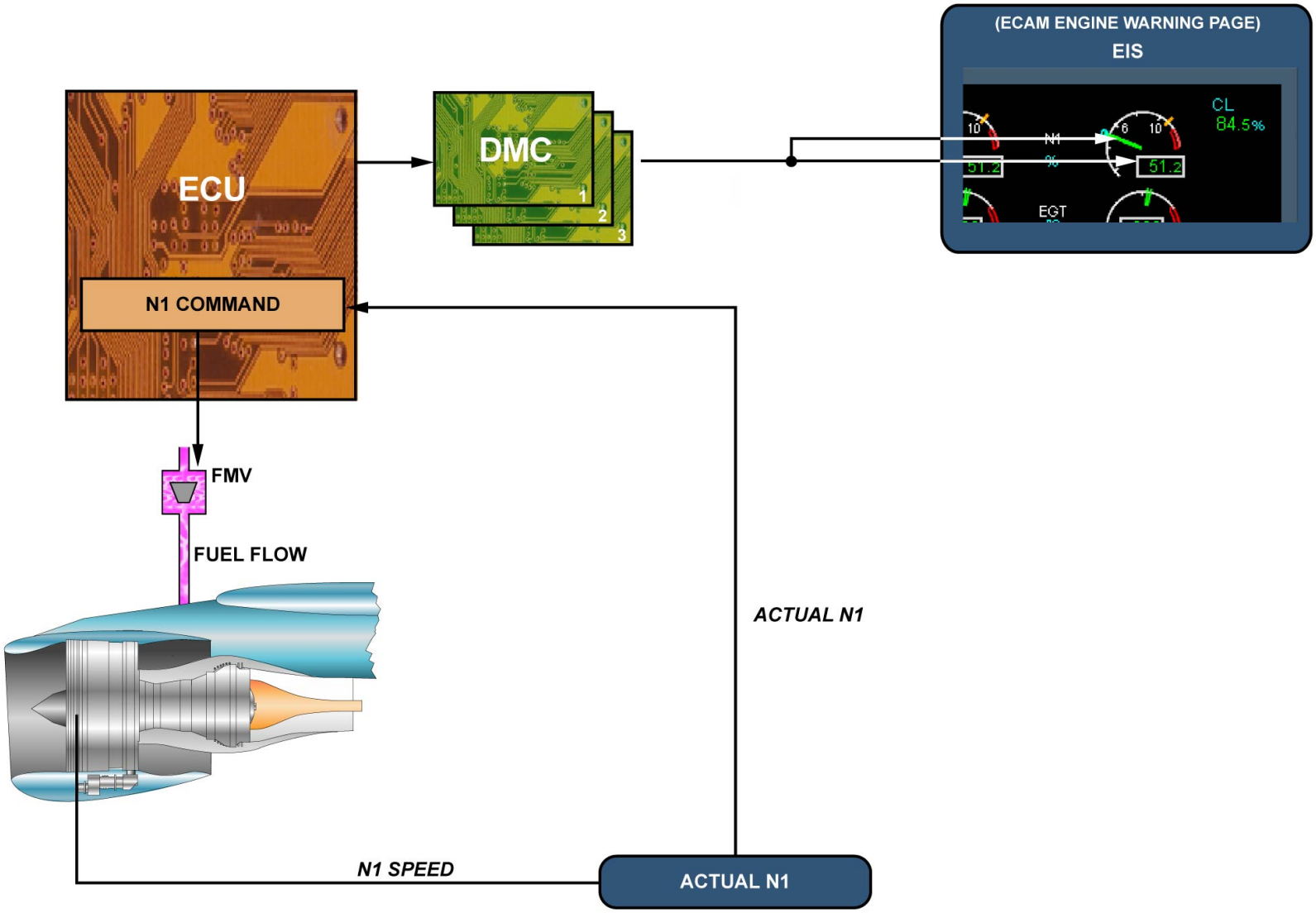
ENGINE THRUST MANAGEMENT (3)

BASIC INFORMATION (continued)

ACTUAL N1

The actual N1 is the actual value given by the N1 speed sensor.
This actual N1 is displayed in green on the N1 indicator and this actual N1 signal is also compared to the N1 command.

UG913131 - U7RT0EC - UM76D1CFM000001



BASIC INFORMATION - ACTUAL N1

ENGINE THRUST MANAGEMENT (3)

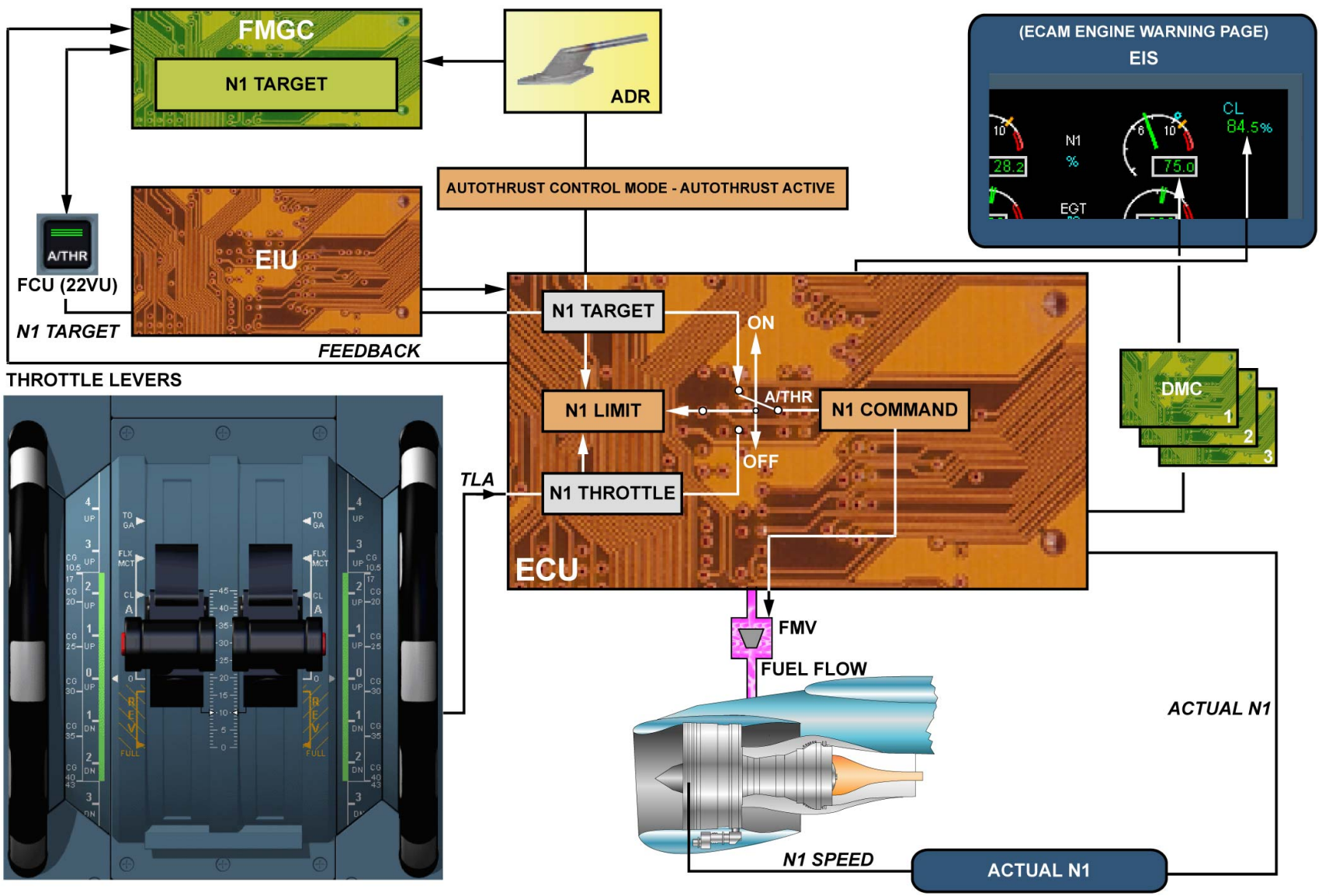
AUTOTHRUST CONTROL MODE

The A/THR function is engaged manually when the A/THR P/B is selected or automatically at take off power application.

AUTOTHRUST ACTIVE

When engaged, the A/THR function becomes active when the throttle levers are set to CLimb detent after take off. The N1 command is the FMGC N1 target.
A/THR function is normally active when the throttle levers are set between IDLE and CLimb (including CLimb).
The A/THR active range is extended to MCT in the case of single engine operation.
When the throttle levers are set between two detent points, the N1 command is limited by the throttle lever position.
Note: In Alpha Floor condition the A/THR function becomes active automatically. The N1 target is TOGA.

UG913131 - U7RT0EC - UM76D1CFM000001



AUTOTHRUST CONTROL MODE - AUTOTHRUST ACTIVE

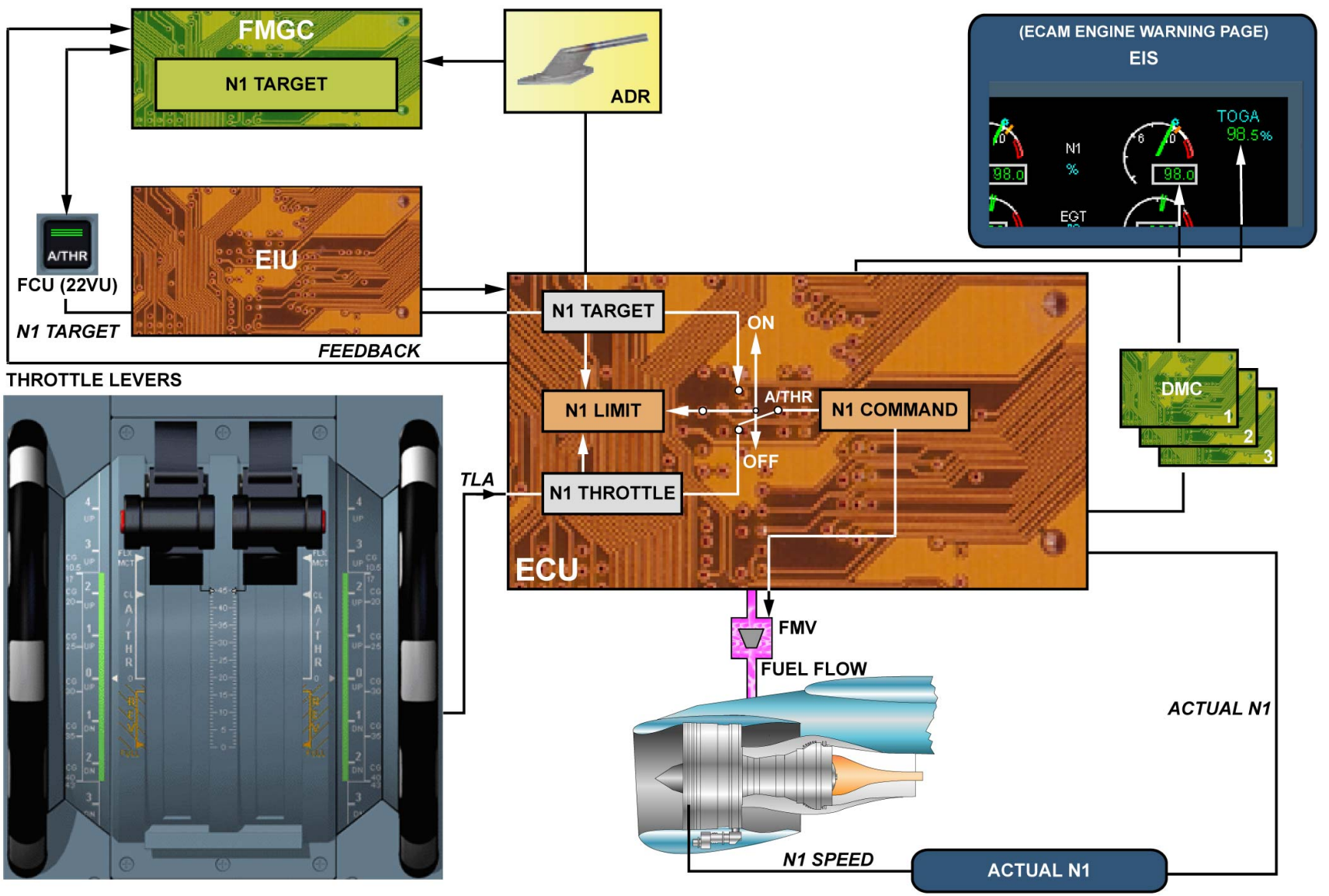
ENGINE THRUST MANAGEMENT (3)

AUTOTHRUST CONTROL MODE (continued)

AUTOTHRUST NOT ACTIVE

When engaged, the A/THR function becomes inactive when the throttle levers are set above CLimb with 2 engines running.
The N1 command corresponds to the TLA. A/THR function is not active above MCT in case of single engine operation.
The A/THR function is disengaged when the throttle levers are set at IDLE stop.

UG913131 - U7RT0EC - UM76D1CFM000001



AUTOTHRUST CONTROL MODE - AUTOTHRUST NOT ACTIVE

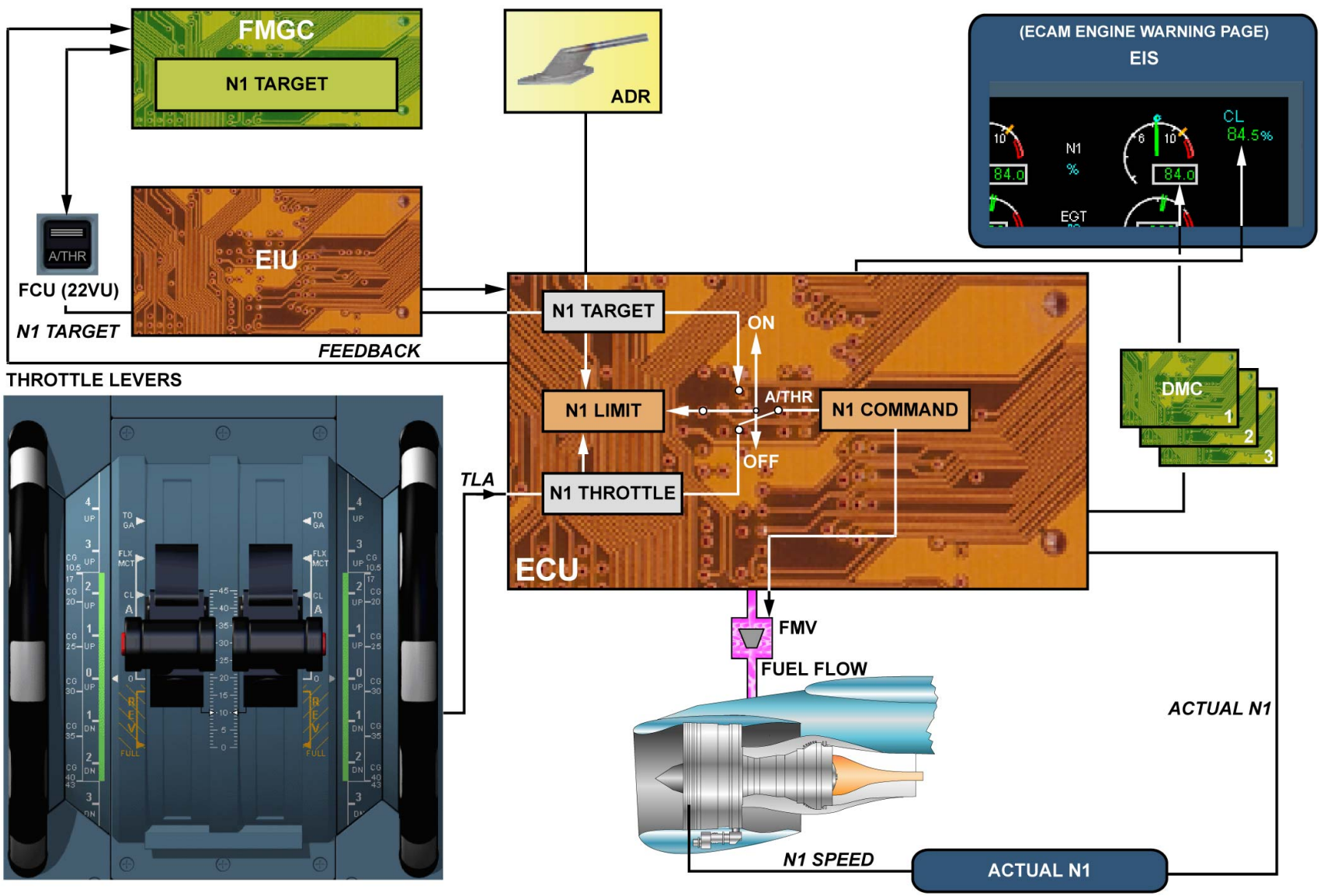
UG913131 - U7RT0EC - UM76D1CFM000001

ENGINE THRUST MANAGEMENT (3)

MANUAL CONTROL MODE

Manual mode when A/THR not engaged.
The ECU processes the N1 command signal according to the TLA.

UG913131 - U7RT0EC - UM76D1CFM000001



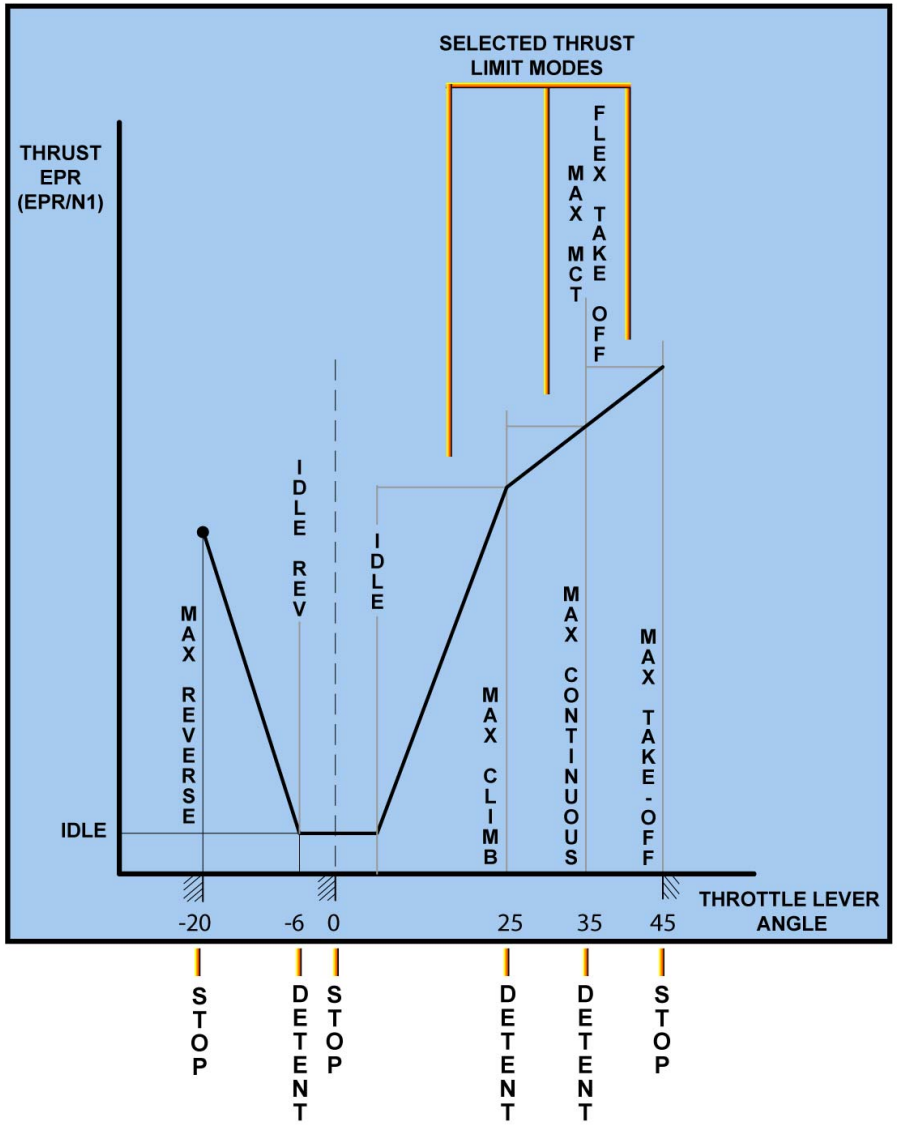
MANUAL CONTROL MODE

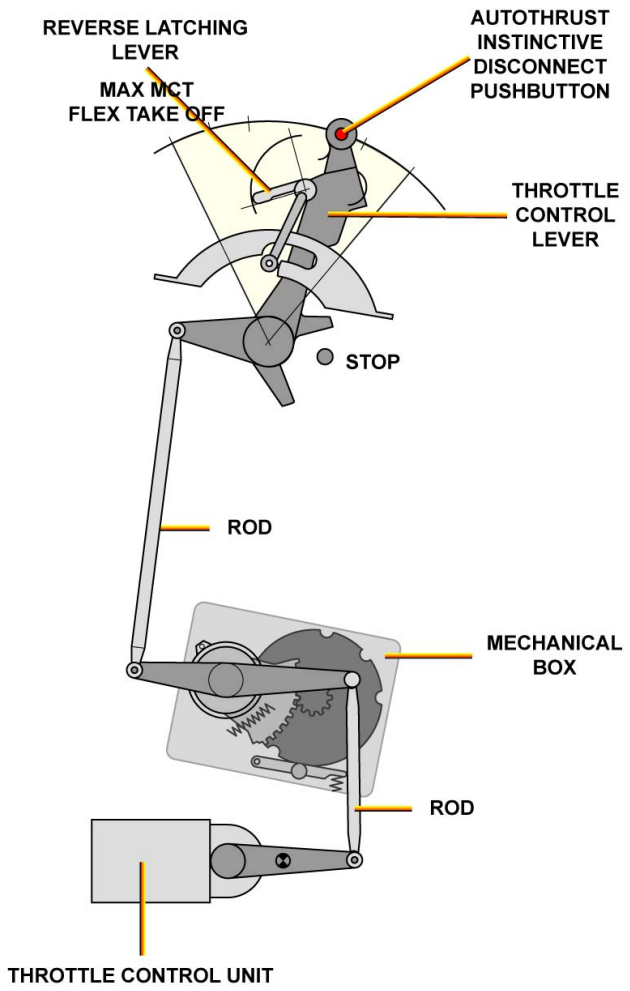
THROTTLE CONTROL SYSTEM D/O (3)

THROTTLE CONTROL LEVER

The Throttle control handle comprises:
o a throttle control lever which incorporates stop devices, autothrust instinctive disconnect pushbutton switch
o a graduated fixed sector
o a reverse latching lever.
The throttle control lever is linked to a mechanical rod. This rod drives the input lever of the throttle control artificial feel unit.
The throttle control lever moves over a range from -20 deg. TLA (Reverser Full Throttle stop) to +45 deg. TLA:
o -20 degrees TLA corresponds to Reverser Full Throttle stop
o +45 degrees TLA corresponds to Forward Full Throttle stop
An intermediate mechanical stop is set to 0 deg.TLA. This stop is overridden when the reverse latching lever is pulled up for selection of the reverse power. This stop is reset as soon as the throttle control lever is selected back to forward thrust area.
In the forward thrust area, there are two detent points, the MAX CLIMB detent point set to 25 deg.TLA and the MAX CONTINUOUS/FLEX TAKE-OFF detent point set to 35 deg.TLA.
In the reverse thrust throttle range, there is one detent point at - 6 deg.TLA. This position agrees with the selection of the thrust reverser command and the Reverse Idle setting.
In the middle throttle range (0deg. To 35 deg.TLA), the autothrust function can be active if engaged. This range agrees with the selection of MAX CLIMB or MAX CONTINUOUS thrust limit mode (in single operation). If the autothrust is not engaged, the engine control is manual.
In the forward range (35 deg. To 45 deg.TLA), the autothrust function cannot be activated (except in alpha floor condition).This range agrees with the selection of FLEX TAKE-OFF/MAX TAKE-OFF Mode.

UG913131 - U7RT0EC - UM76D500000001





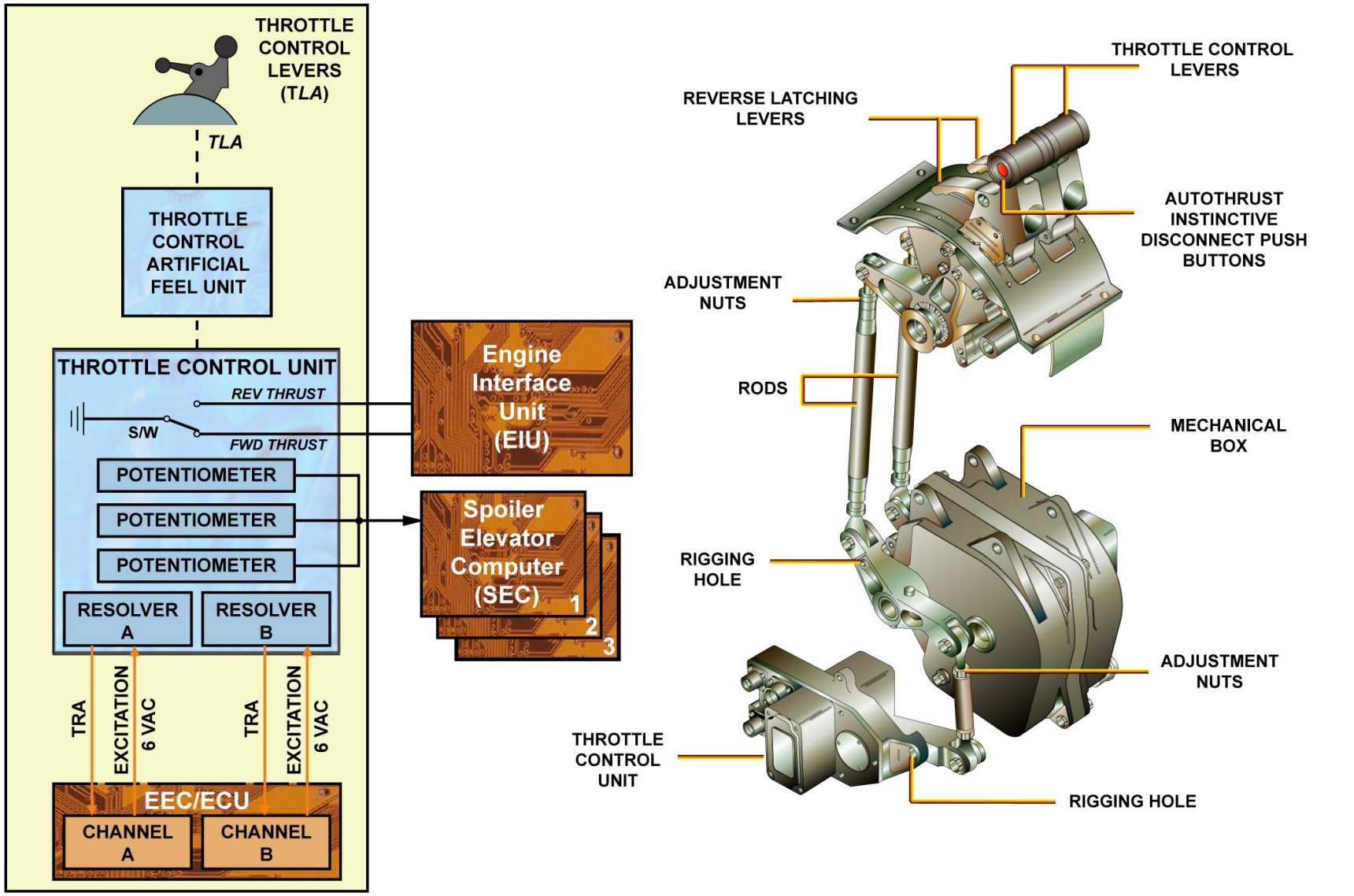
THROTTLE CONTROL LEVER

THROTTLE CONTROL SYSTEM D/O (3)

THROTTLE CONTROL UNIT

A mechanical rod transmits the throttle control lever movement. It connects the throttle artificial feel unit to the input lever of the throttle control unit. The throttle control unit comprises:
-An input lever
-Mechanical stops, which limit the angular range
-2 resolvers (one resolver per FADEC (ECU/EEC)
-6 potentiometers installed three by three
-A device, which drives the resolver and the potentiometer
-A pin device for rigging the resolver and potentiometers
-1 switch whose signal is dedicated to the EIU
-2 output electrical connectors
The input lever drives two gear sectors assembled face to face. Each sector drives itself a set of one resolver and three potentiometers. The relationship between the throttle lever angle and throttle resolver angle (TRA) IS LINEAR AND 1 DEG.TLA = 1.9 TRA. The accuracy of the throttle control unit (error between the input lever position and the resolver angle) is 0.5 deg.TRA. The maximum discrepancy between the signals generated by two resolvers is 0.25 deg.TRA.
The TLA resolver operates in two quadrants. The first quadrant is used for positive angles and the second quadrant for negative angles. Each resolver is dedicated to one FADEC channel (ECU / EEC) and receives its electrical excitation current (6 VAC) from the related FADEC channel (ECU / EEC)
The ECU considers a throttle resolver angle value:
o less than -47.5 deg.TRA
or
o greater than 98.8 deg.TRA as resolver position signal failure.
The ECU includes a resolver fault accommodation logic. This logic allows engine operation after a failure or a complete loss of the throttle resolver position signal.

UG913131 - U7RT0EC - UM76D500000001



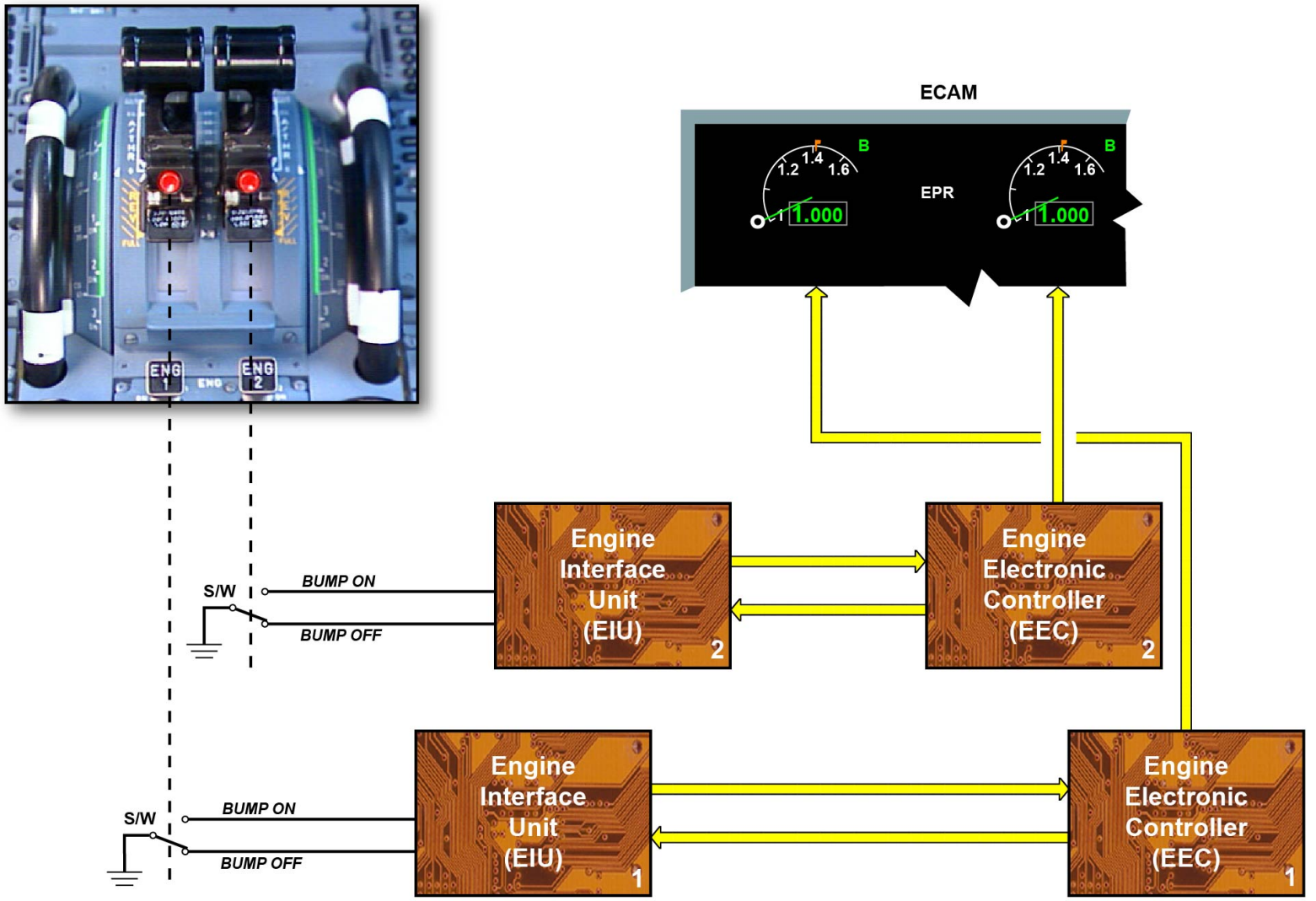
THROTTLE CONTROL UNIT

THROTTLE CONTROL SYSTEM D/O (3)

BUMP FUNCTION (IAE ENGINES ONLY)

If an airline requests the bump function, this function is selected in the aircraft by a pushbutton switch (one on each throttle control lever). With this switch, a signal can be sent to the two FADEC units at the same time through the Engine Interface Unit (EIU).

UG913131 - U7RT0EC - UM76D500000001



BUMP FUNCTION (IAE ENGINES ONLY)

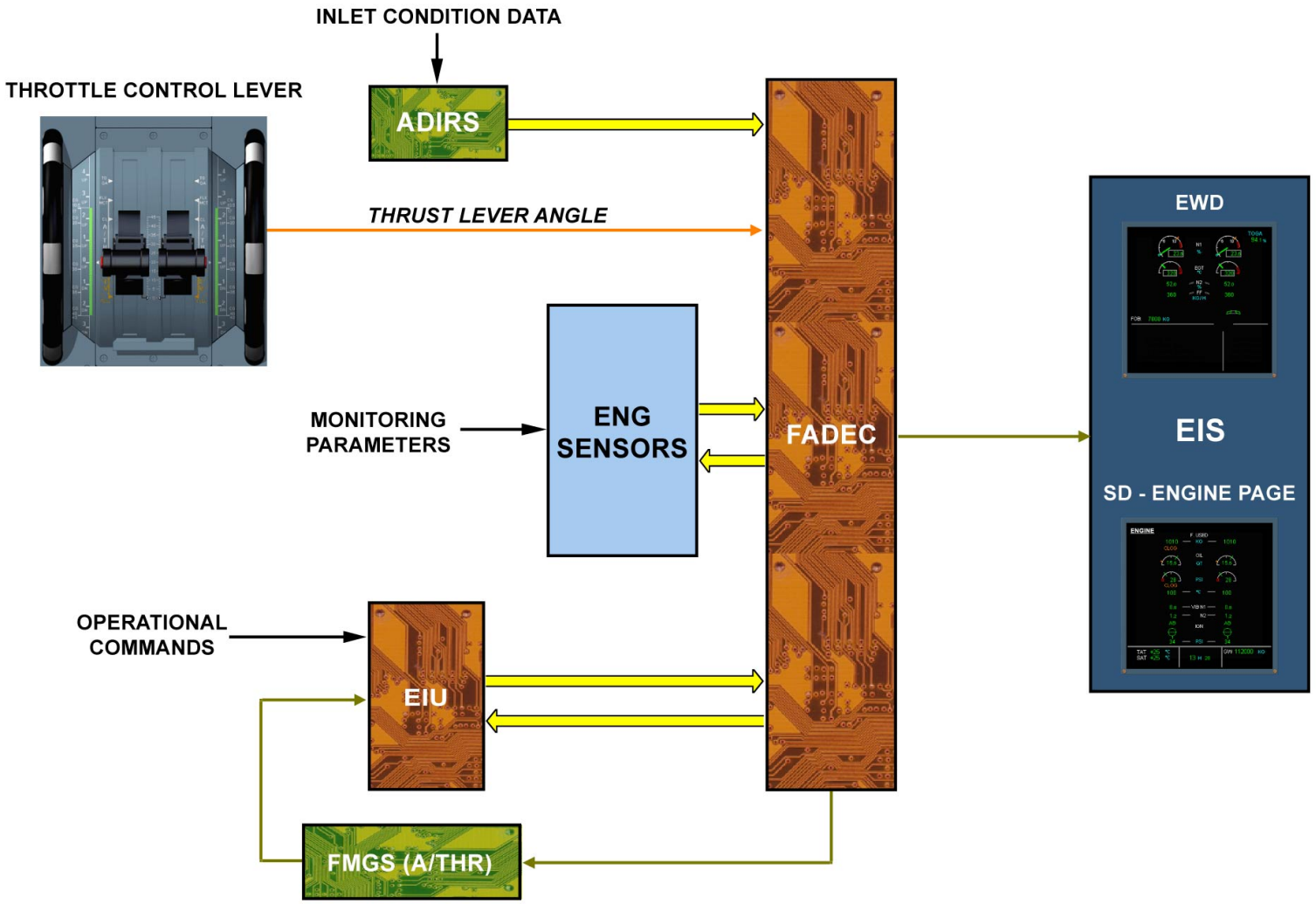
UG913131 - U7RT0EC - UM76D5000000001

ENGINE MONITORING D/O (3)

INTRODUCTION

The engine monitoring is carried out by means of the Electronic Control Unit (ECU) and the vibration monitoring system with a display on the ECAM.
The ECU receives engine inlet condition data from the Air Data/Inertial Reference System (ADIRS), operational commands from the Engine Interface Unit (EIU), and monitoring parameters from the various dedicated engine sensors.

UG913131 - U7RT0EC - UM77D2CFM000002

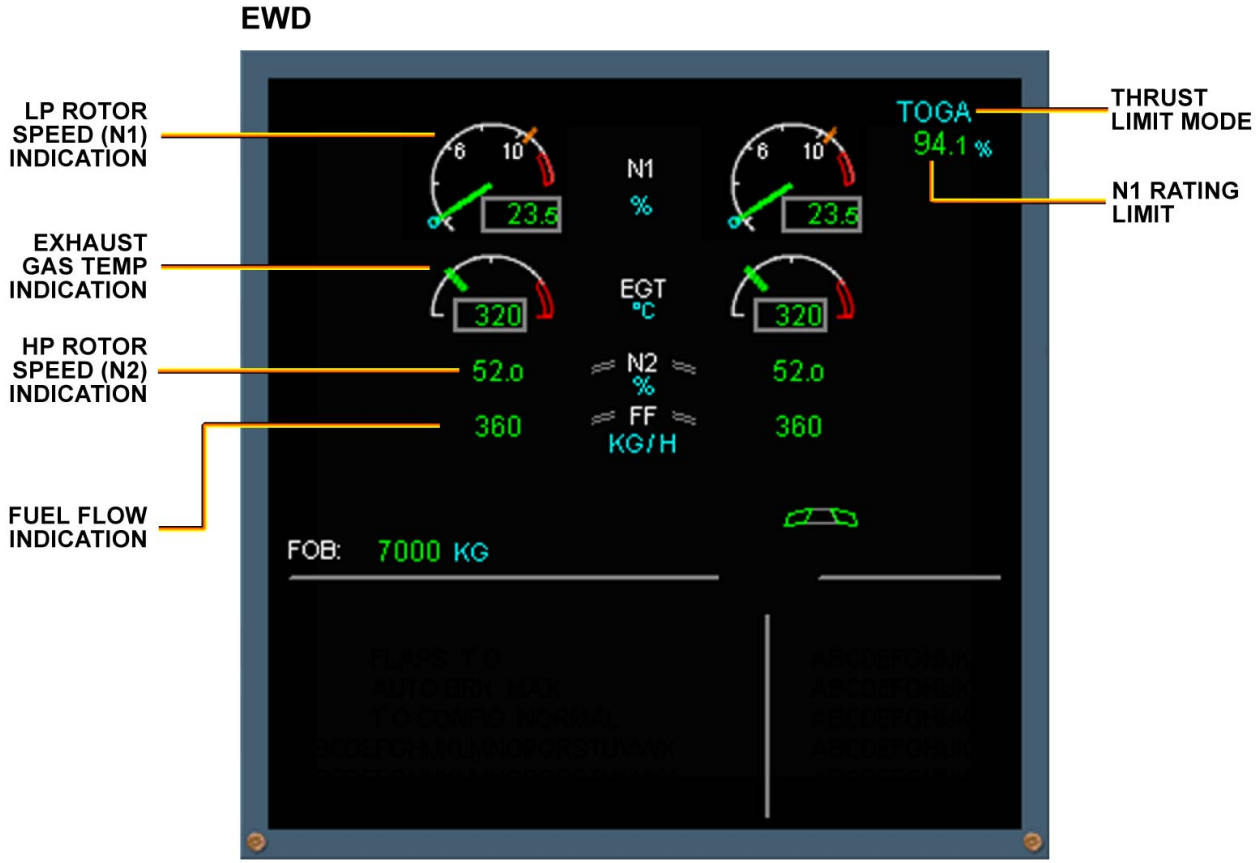


INTRODUCTION

ENGINE MONITORING D/O (3)

PRIMARY PARAMETERS

The engine primary monitoring parameters displayed on the ECAM EWD are:
- Low Pressure (LP) rotor speed indication (N1),
- Exhaust Gas Temperature (EGT) indication,
- High Pressure (HP) rotor speed indication (N2),
- Fuel Flow (FF) indication,
- thrust limit mode,
- N1 rating limit.



PRIMARY PARAMETERS

ENGINE MONITORING D/O (3)

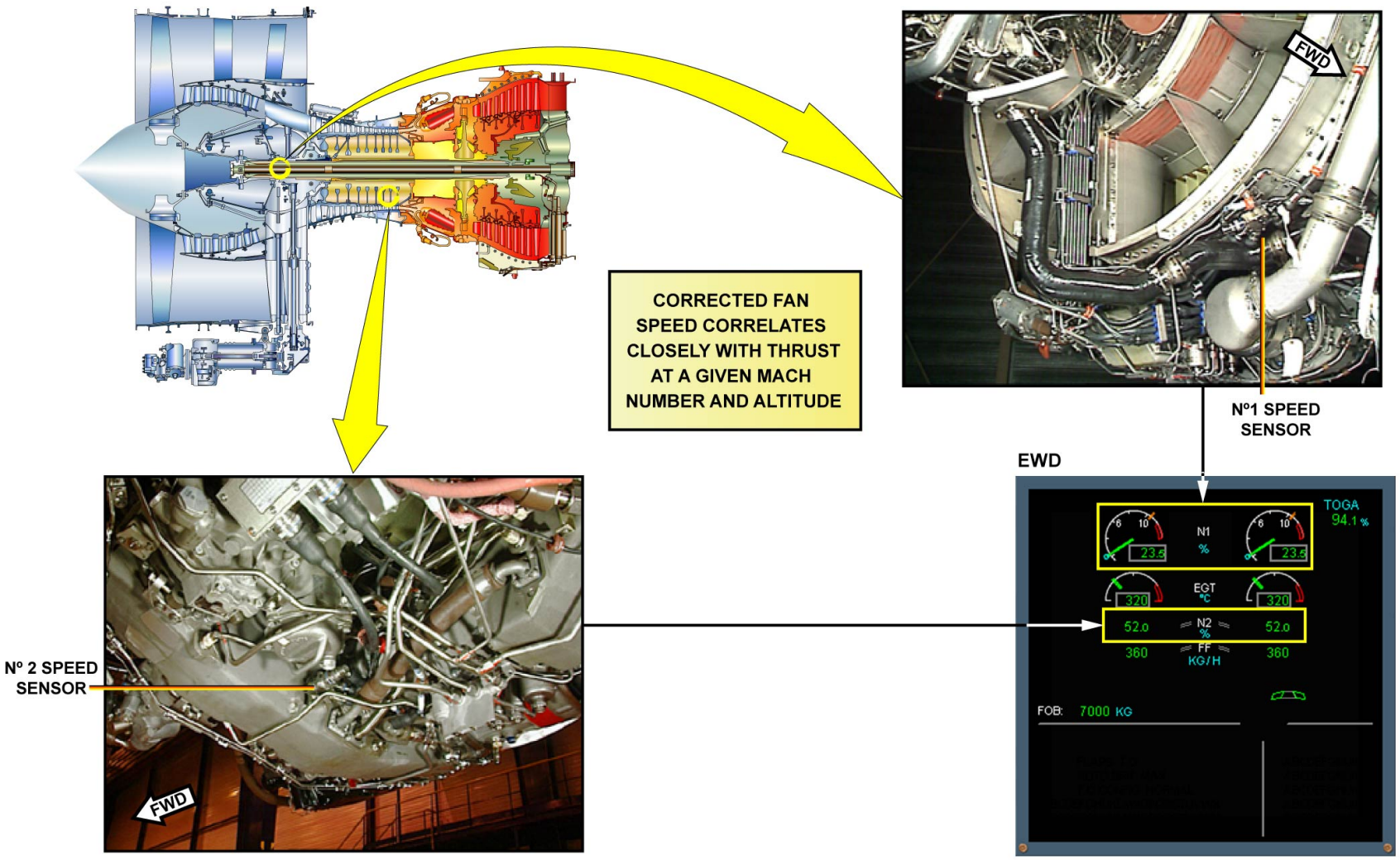
PRIMARY PARAMETERS (continued)

ROTATIONAL SPEED PARAMETERS DESCRIPTION

The N1 speed sensor is installed in the fan frame strut No.6 at the 5:00 o'clock position. It senses the LP rotor assembly rotational speed and transmits the corresponding signals to the Engine Vibration Monitoring Unit (EVMU) and the ECU. The N1 rotational speed indication is shown in the ECAM EWD by a needle and a N1 digital indication display.

The N2 speed sensor is installed at 6:30 o'clock on the Accessory Gearbox (AGB) rear face. The N2 speed sensor detects the rotational speed of the HP rotor assembly and transmits the signal to the EVMU and the ECU. The N2 rotational speed is indicated in the ECAM EWD.

UG913131 - U7RT0EC - UM77D2CFM000002



PRIMARY PARAMETERS - ROTATIONAL SPEED PARAMETERS DESCRIPTION

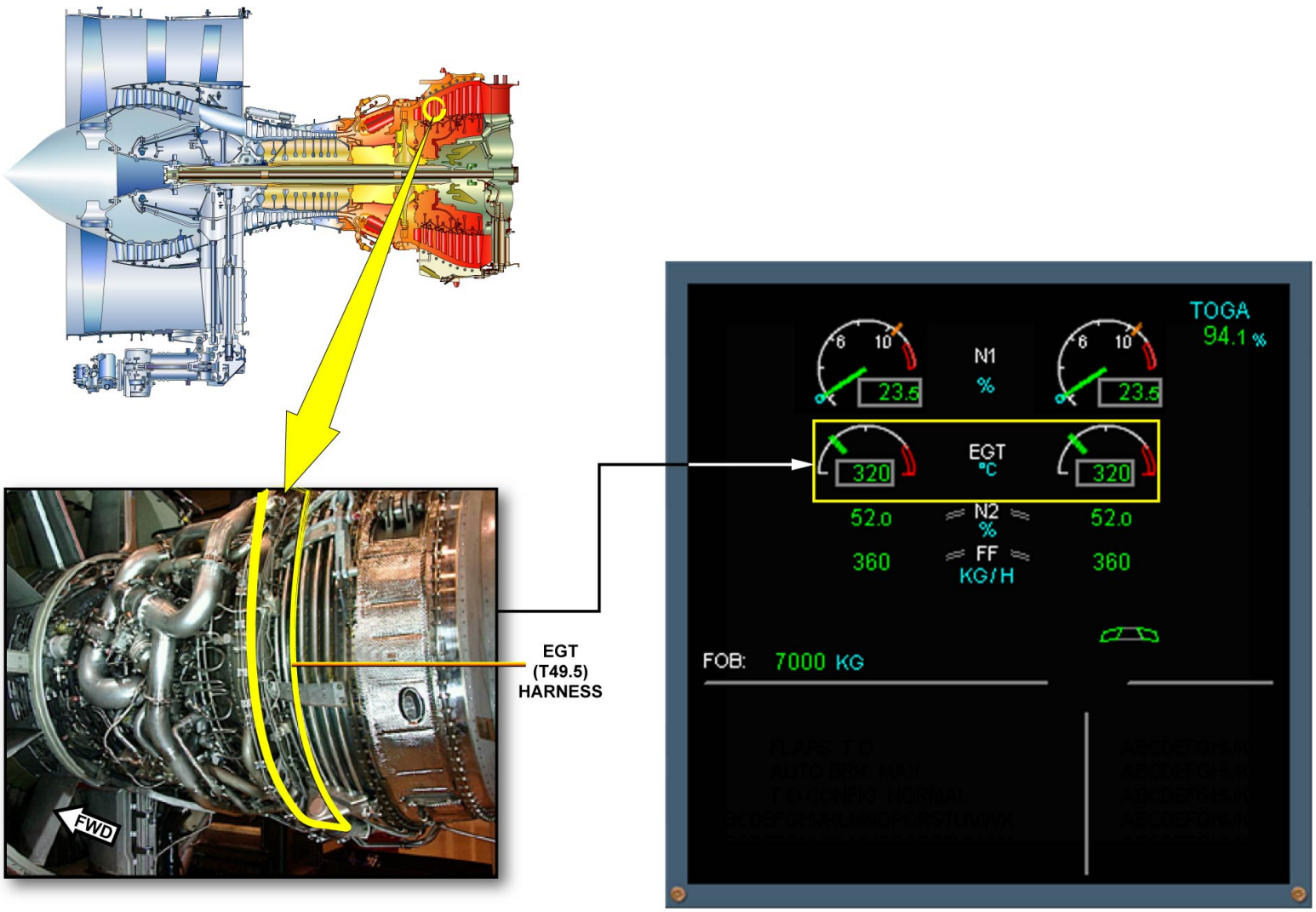
ENGINE MONITORING D/O (3)

PRIMARY PARAMETERS (continued)

LPT SECTION PARAMETERS DESCRIPTION

The engine EGT is sensed and averaged by 9 thermocouple probes located in the T49.5 plane of Low Pressure Turbine (LPT) stage-2 nozzle assembly. The actual engine EGT is displayed in the ECAM EWD by a needle and an EGT digital indication.

UG913131 - U7RT0EC - UM77D2CFM000002



PRIMARY PARAMETERS - LPT SECTION PARAMETERS DESCRIPTION

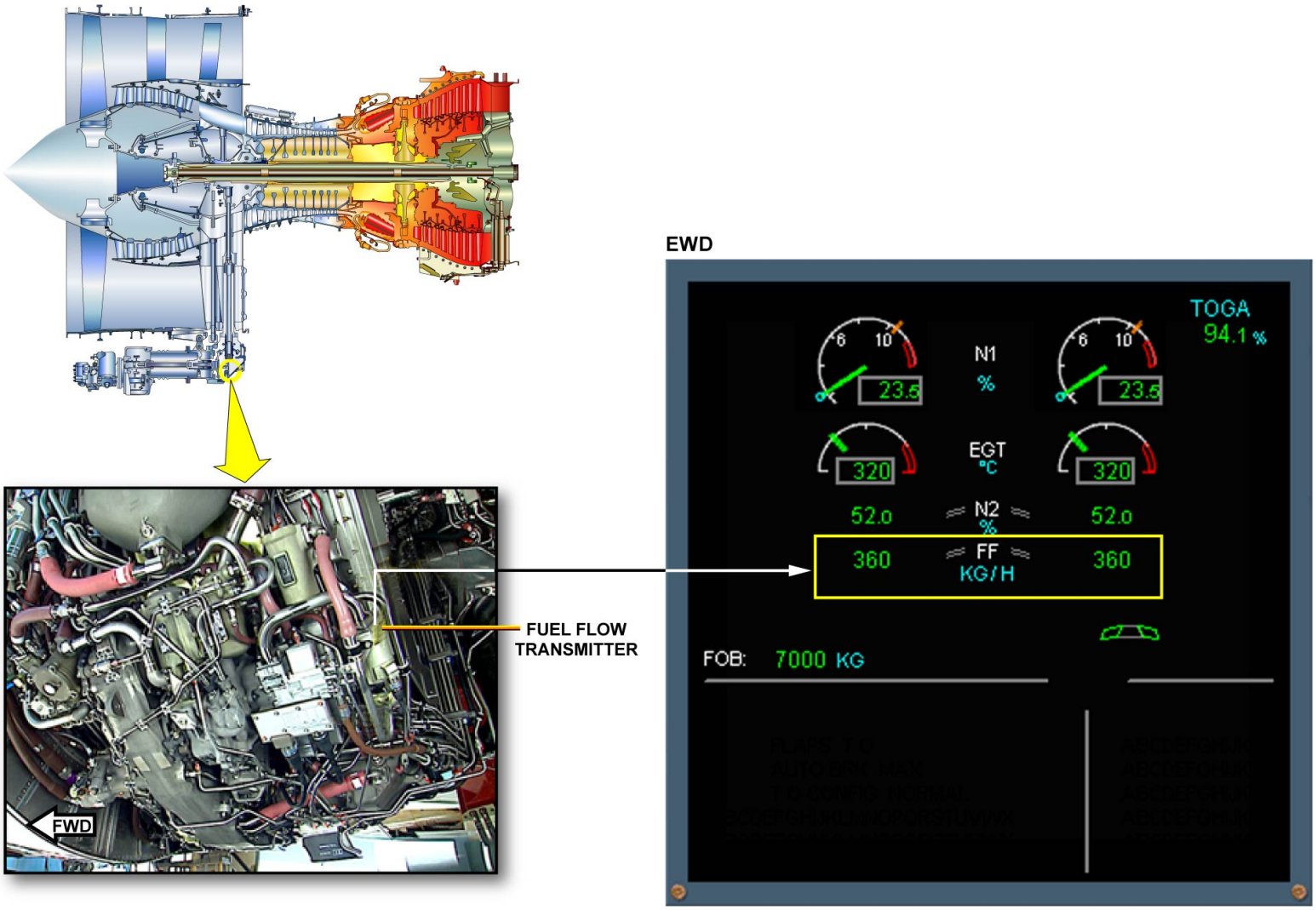
ENGINE MONITORING D/O (3)

PRIMARY PARAMETERS (continued)

FUEL FLOW PARAMETER DESCRIPTION

The FF transmitter (XMTR) is mounted at 7 o'clock on the engine next to the AGB and does not require an electrical power input. The maximum flow across this XMTR is 6360 kg/hr (14000 lb/hr). The FF is shown in the ECAM EWD by a FF digital indication.

UG913131 - U7RT0EC - UM77D2CFM000002



PRIMARY PARAMETERS - FUEL FLOW PARAMETER DESCRIPTION

ENGINE MONITORING D/O (3)

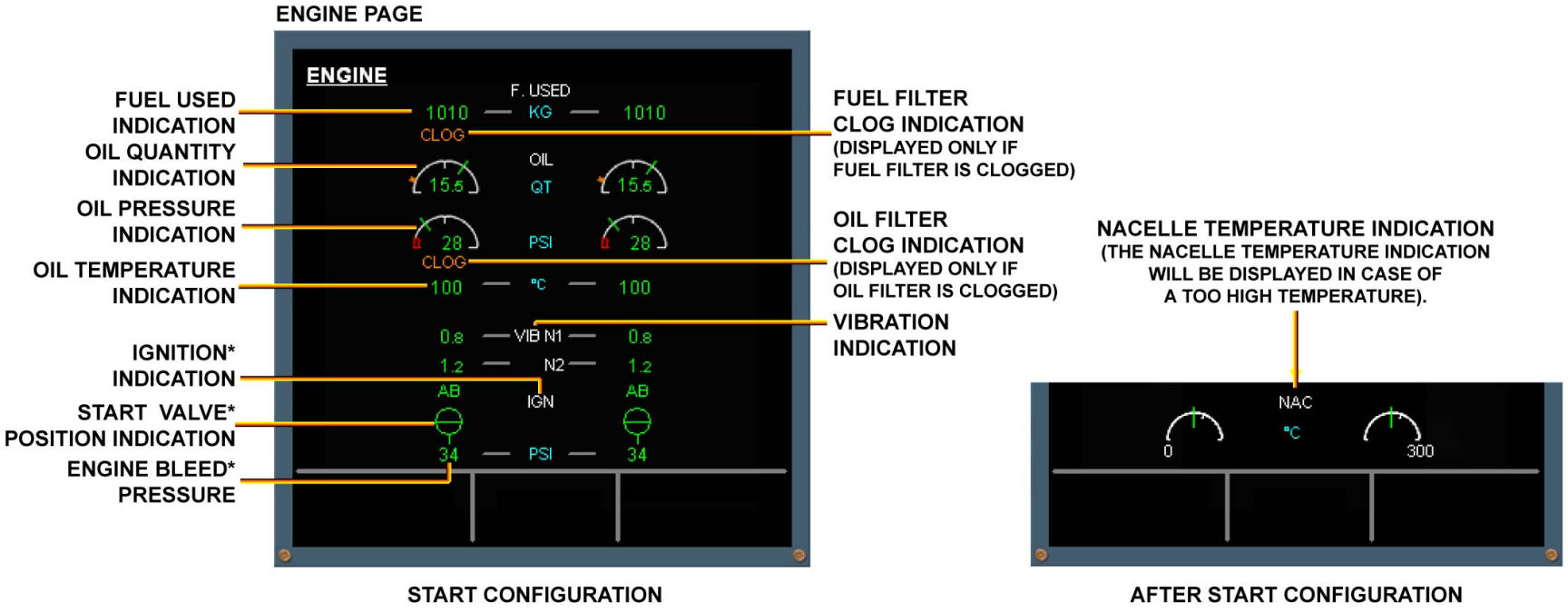
SECONDARY PARAMETERS

The engine secondary monitoring parameters are displayed on the ECAM lower SD when it is selected manually or automatically.
The engine secondary parameters that appear permanently in the ECAM ENGINE page are:
- fuel used indication,
- oil quantity indication,
- oil pressure indication,
- oil temperature indication,
- ignition indication,
- start valve position indication,
- engine bleed pressure,
- vibration indication.

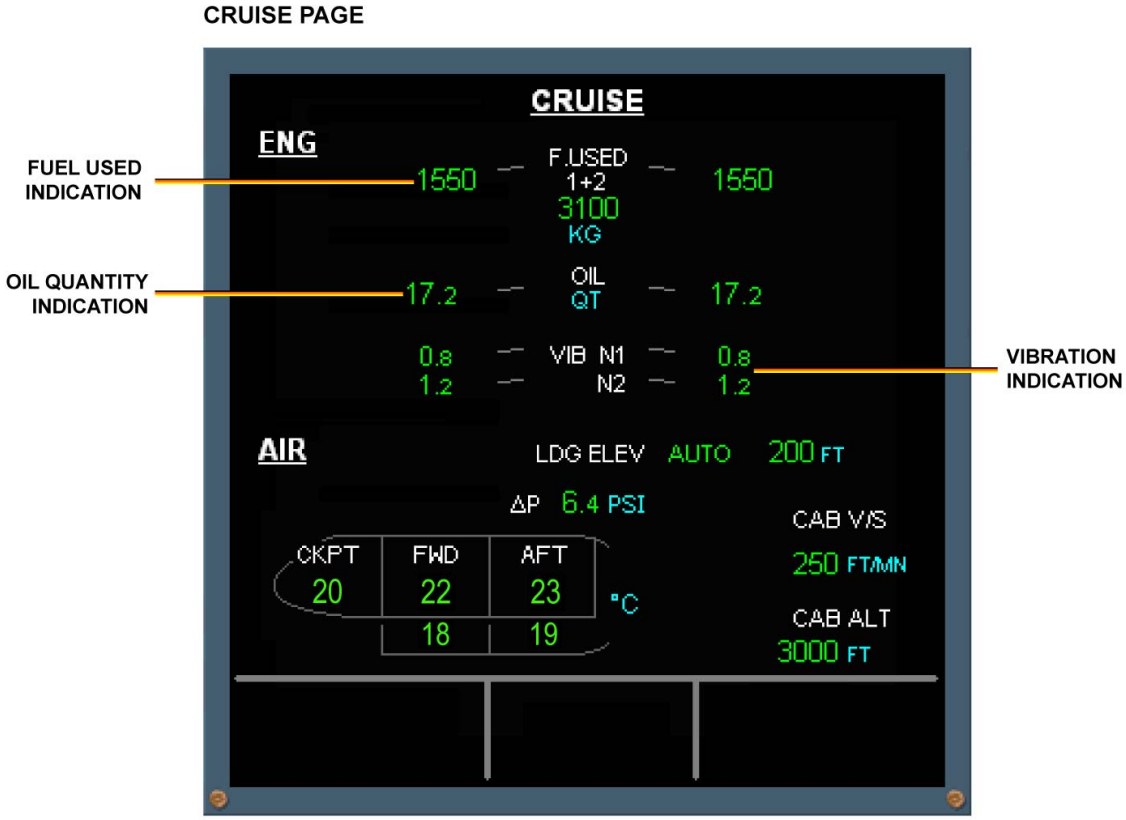
The engine secondary parameters non permanently displayed on the SD are:
- oil filter clog indication,
- fuel filter clog indication,
- nacelle temperature indication.

Fuel used, oil quantity and vibration indications are also displayed on the ECAM CRUISE page.

UG913131 - U7RT0EC - UM77D2CFM000002



SECONDARY PARAMETERS



SECONDARY PARAMETERS

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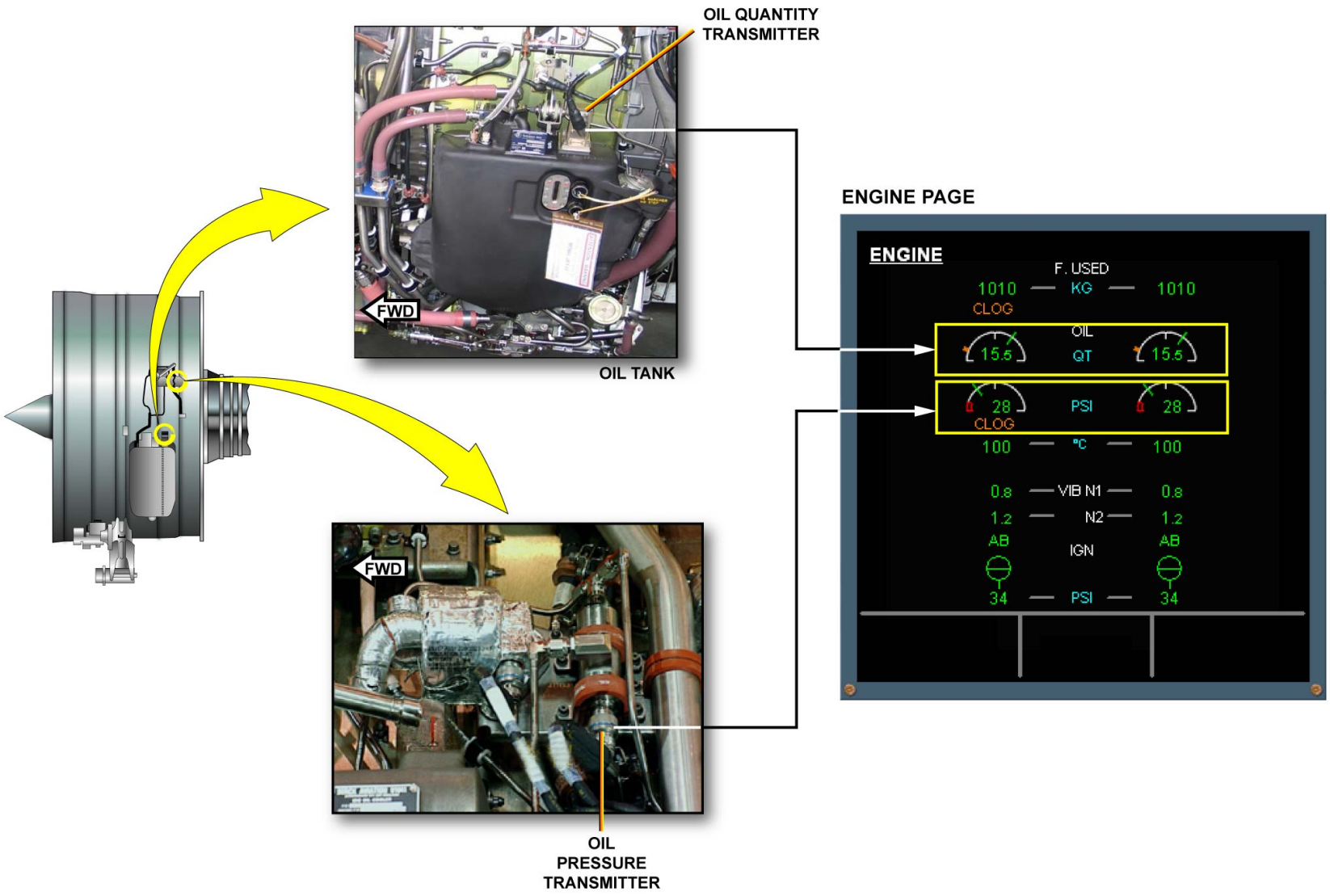
ENGINE MONITORING D/O (3)

SECONDARY PARAMETERS (continued)

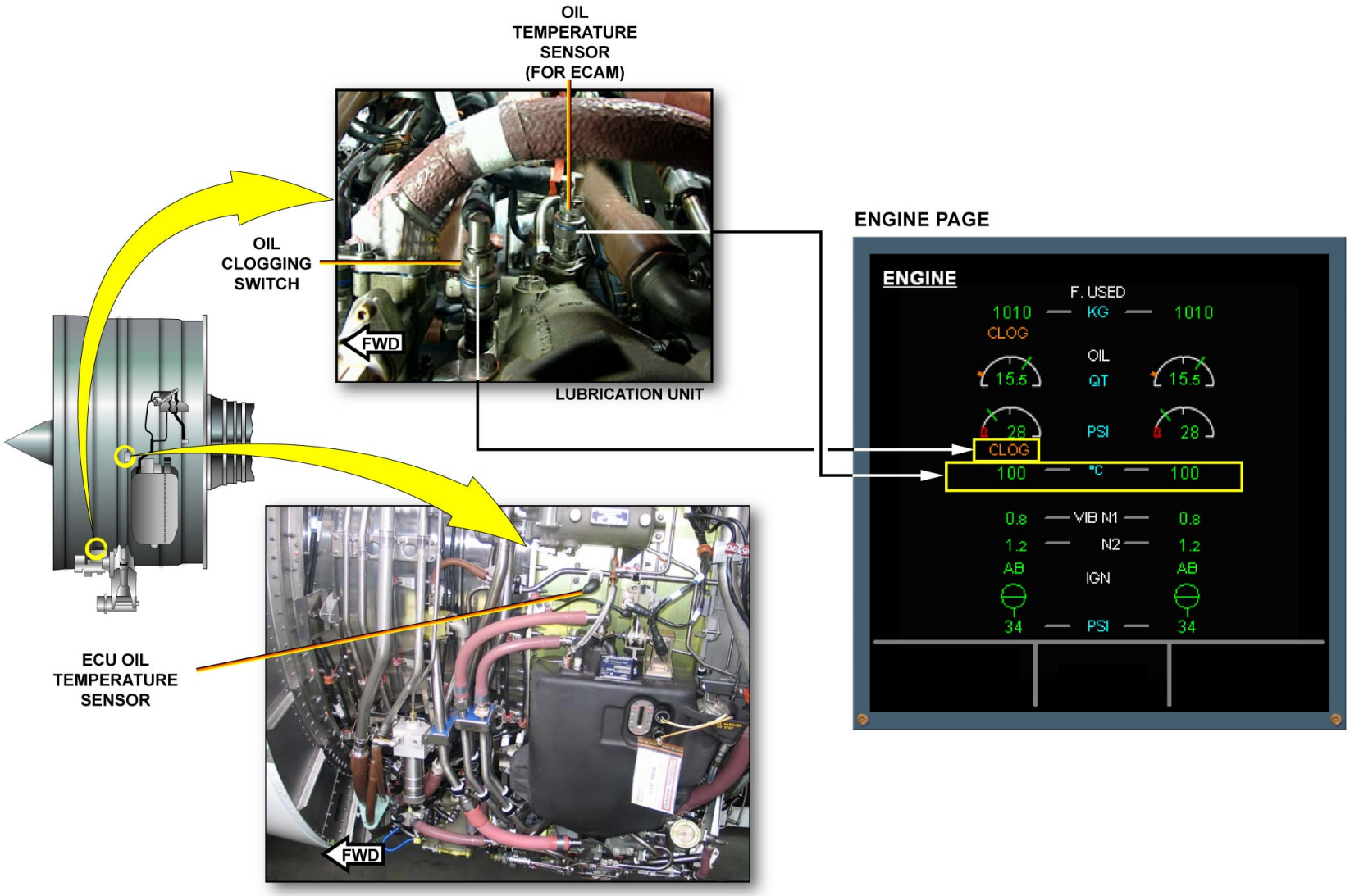
OIL PARAMETERS DESCRIPTION

The oil quantity XMTR is located in the oil tank. It is displayed on ECAM SD.
The oil pressure XMTR is located on the lubrication unit outlet line. It is displayed on ECAM SD.
An oil temperature sensor for the Engine Condition Monitoring (signal to EIU) is located on the main oil pressure filter housing of the lubrication unit, downstream of the pressure pump oil system. It is displayed on the ECAM SD.
An oil differential pressure switch (also named oil clogging switch) is installed on the lubrication unit. The pressure switch signal is used by the ECAM system to generate the main oil filter clog indication when the oil differential pressure across this filter is comprised between 29 psig (2 bar) and 33 psig (2.28 bar).
An engine oil temperature sensor for the Integrated Drive Generator (IDG) cooling system control (signal to ECU) is located above the oil tank.

UG913131 - U7RT0EC - UM77D2CFM000002



SECONDARY PARAMETERS - OIL PARAMETERS DESCRIPTION



SECONDARY PARAMETERS - OIL PARAMETERS DESCRIPTION

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UG913131 - U7RT0EC - UM77D2CFM000002

ENGINE MONITORING D/O (3)

SECONDARY PARAMETERS (continued)

VIBRATION PARAMETERS DESCRIPTION

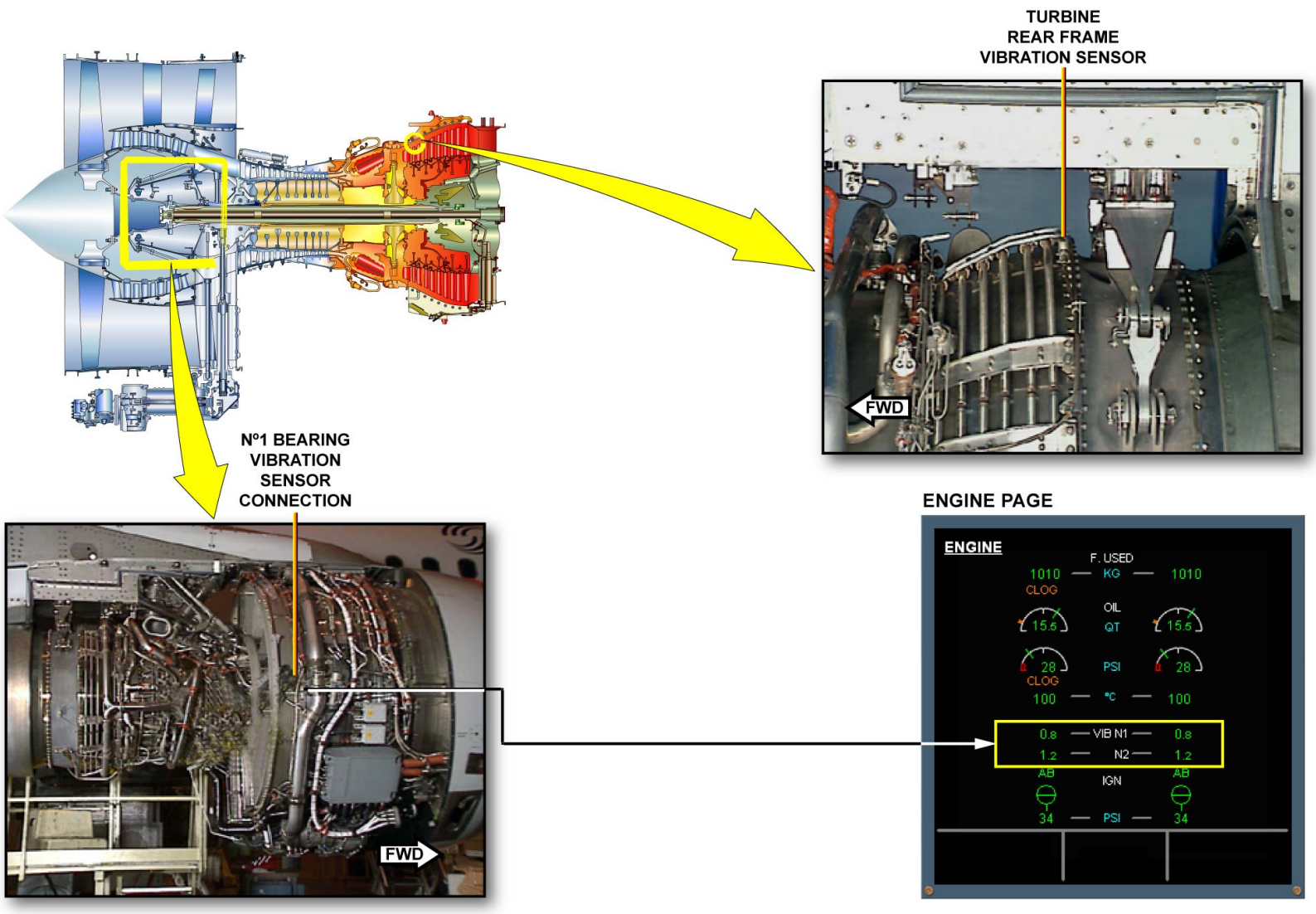
The No. 1 bearing sensor is formed by an accelerometer located at 9:00 o'clock position on No. 1 and No .2 bearing support and a sensor cable that is routed through the fan frame. The No. 1 bearing vibration sensor permanently monitors the vibrations from No. 1 bearing and the vibrations from LPT and High Pressure Turbine (HPT) shafts. It's also used to the fan trim balance procedure.

The Turbine Rear Frame (TRF) vibration sensor is installed at 12 o'clock on the front flange of the TRF. The TRF vibration sensor is used as back-up of N1 bearing accelerometer to monitor and, if necessary, reduce the engine vibration level using the trim balance procedure.

The aircraft EVMU uses the vibration and the rotational speed signals to extract all the vibration signals and compute the position and the amplitude of the unbalanced signals.

As normal vibration is depending on rotor speed, for each speed, the EVMU processes the ratio actual value/maxi value. This ratio is multiplied by 10 and is available on the EVMU output for display on ECAM SD.

UG913131 - U7RT0EC - UM77D2CFM000002



SECONDARY PARAMETERS - VIBRATION PARAMETERS DESCRIPTION

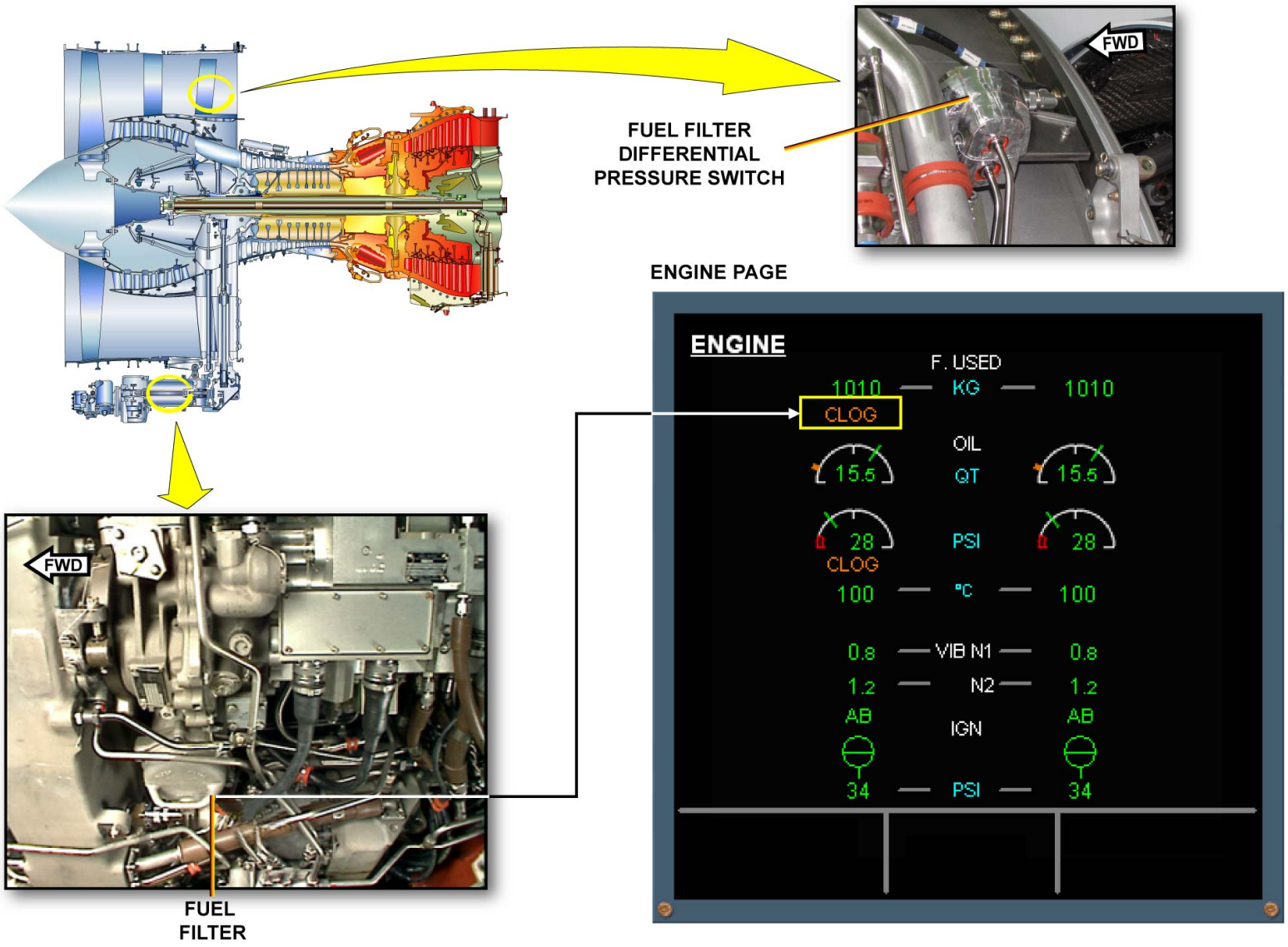
ENGINE MONITORING D/O (3)

SECONDARY PARAMETERS (continued)

FUEL PARAMETERS DESCRIPTION

The fuel used value computed by the Full Authority Digital Engine Control (FADEC) is displayed in green on the ECAM SD.
A CLOG message appears in amber, associated with an ECAM message only when the differential pressure across the fuel filter is excessive.

UG913131 - U7RT0EC - UM77D2CFM000002



SECONDARY PARAMETERS - FUEL PARAMETERS DESCRIPTION

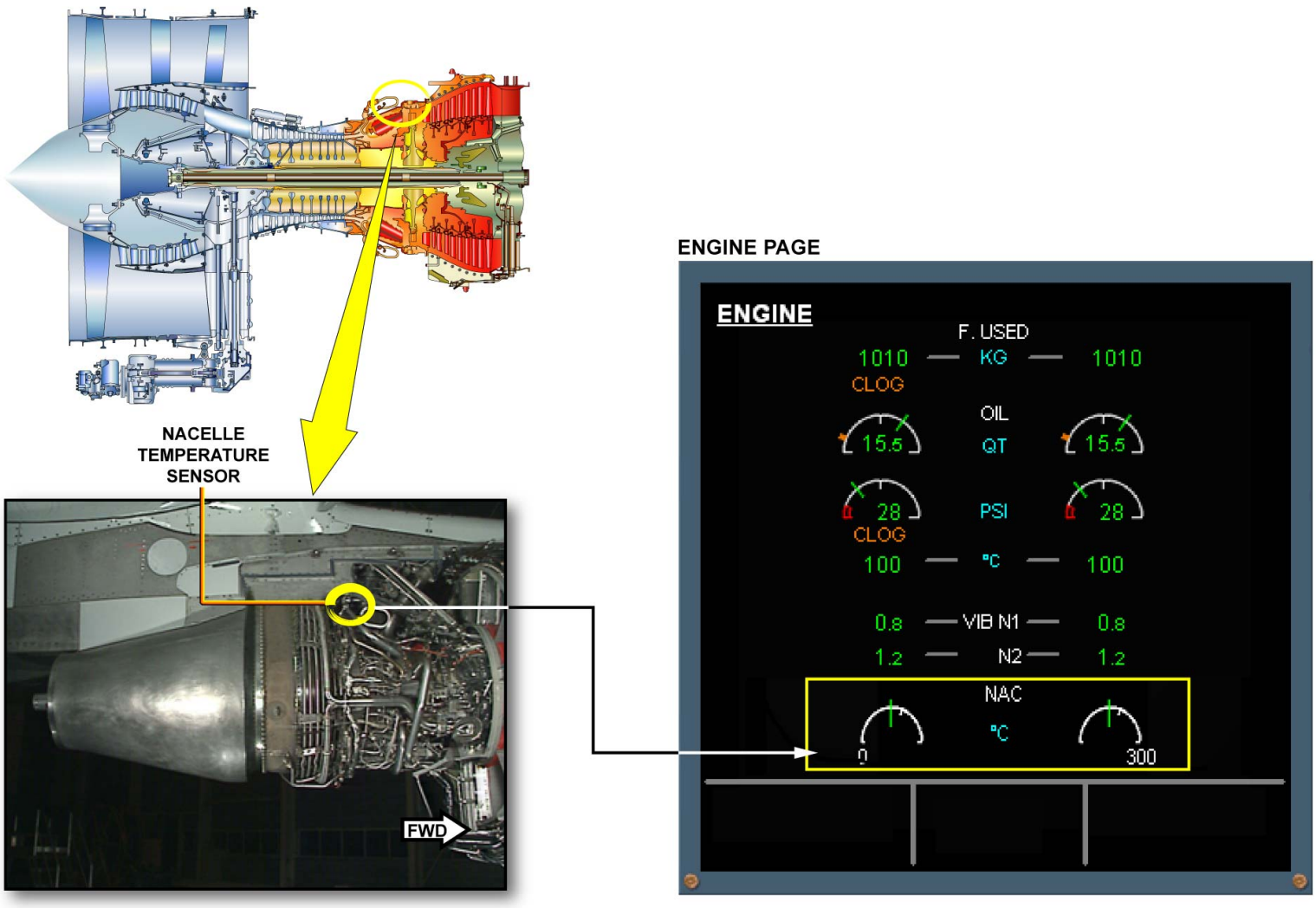
ENGINE MONITORING D/O (3)

SECONDARY PARAMETERS (continued)

NACELLE TEMPERATURE INDICATION

The nacelle temperature is monitored by a temperature probe installed in the ventilated core compartment.
The nacelle temperature sensor can provide indication to the ECAM SD.

UG913131 - U7RT0EC - UM77D2CFM000002



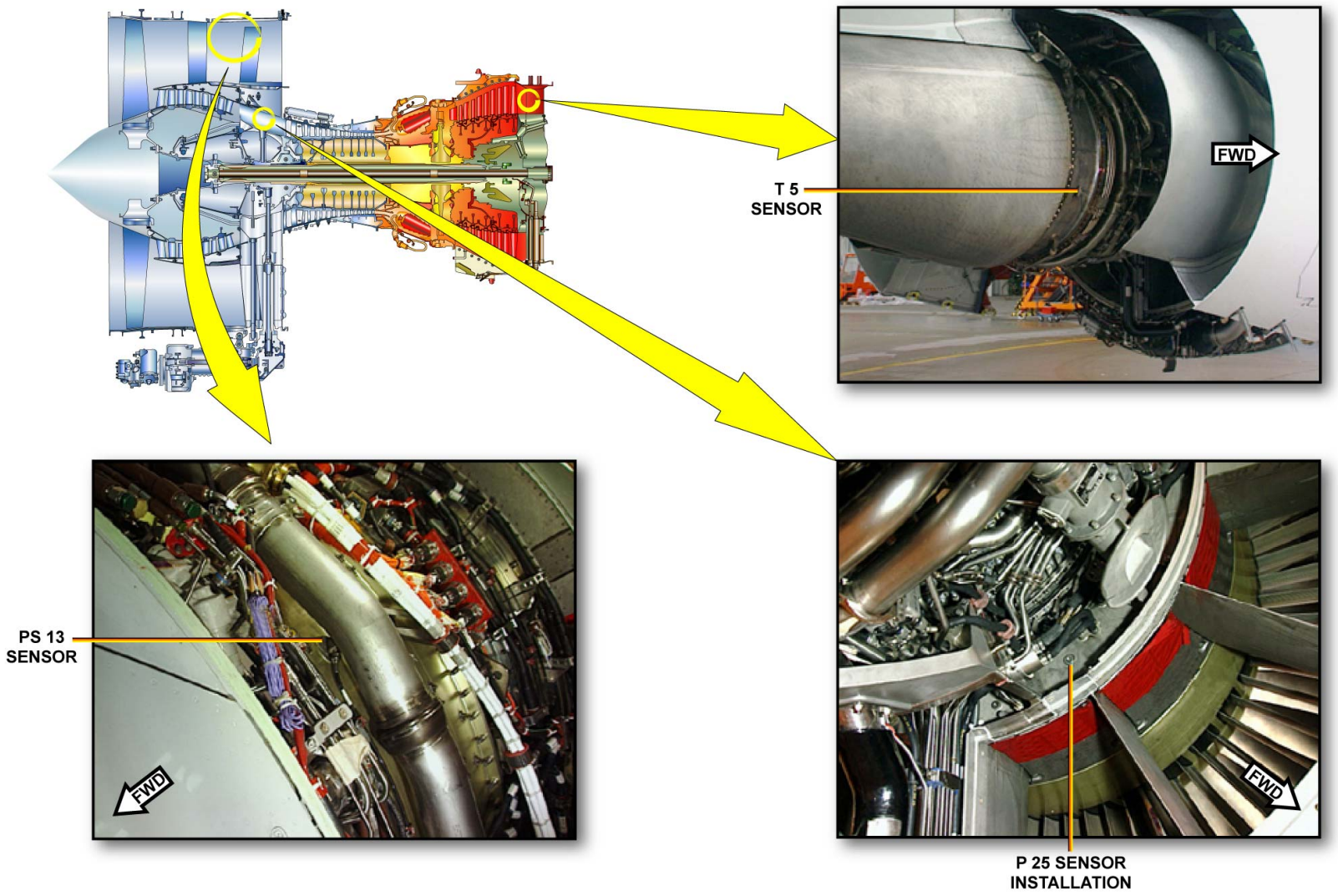
SECONDARY PARAMETERS - NACELLE TEMPERATURE INDICATION

ENGINE MONITORING D/O (3)

OPTIONAL PARAMETERS

The T5 sensor is an optional monitoring sensor that meters the turbine exhaust temperature.
The P25 optional sensor measures the air pressure downstream of the booster or the High Pressure Compressor (HPC) inlet.
PS13 is an optional sensor.

UG913131 - U7RT0EC - UM77D2CFM000002



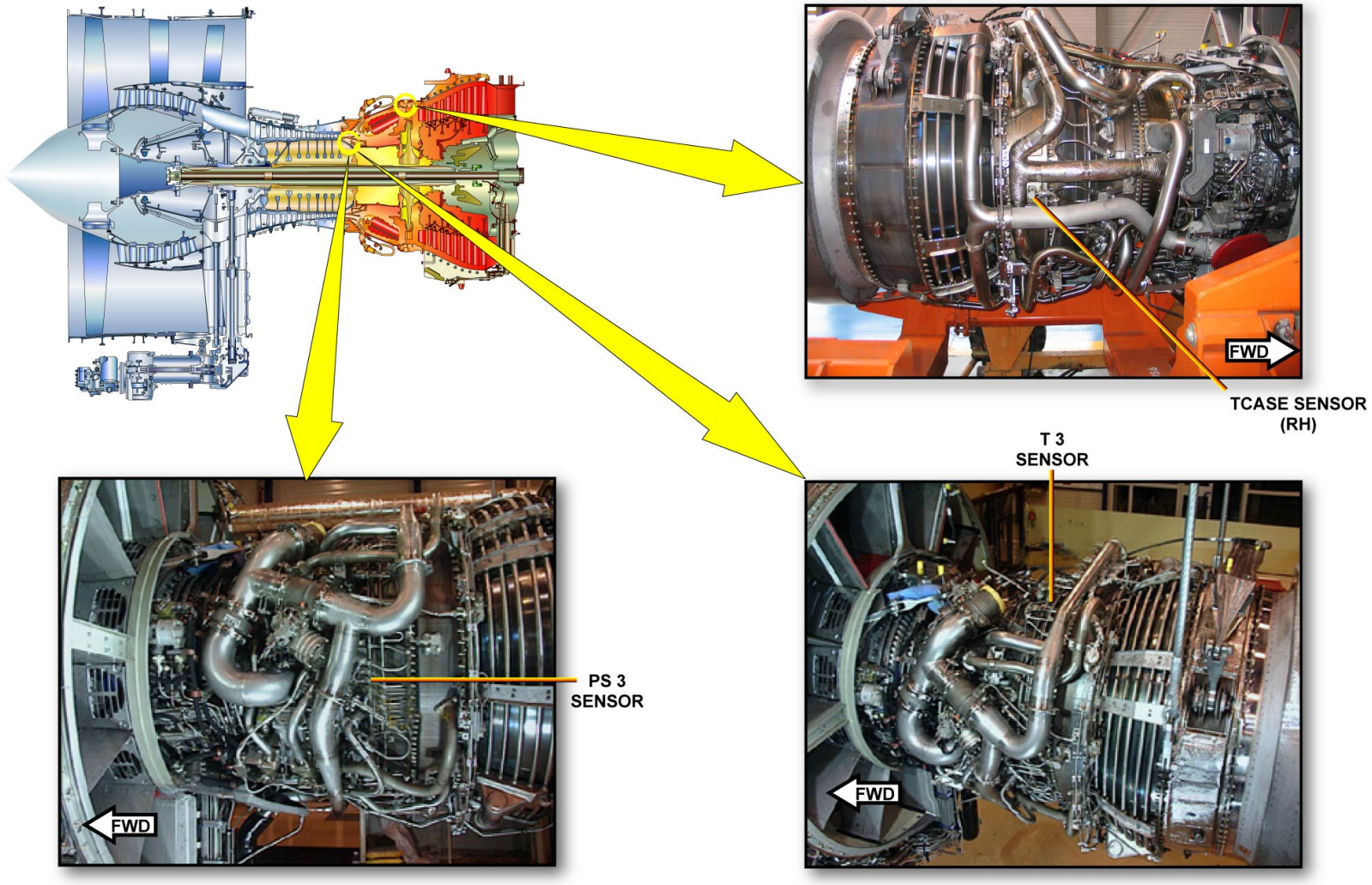
OPTIONAL PARAMETERS

ENGINE MONITORING D/O (3)

COMBUSTION AND HPT SECTION PARAMETERS DESCRIPTION

Tcase sensor is located between the combustion chambers and the HPT.
The T3 sensor measures the compressor discharge temperature.
The PS3 sensor meters the compressor discharge pressure.

UG913131 - U7RT0EC - UM77D2CFM000002



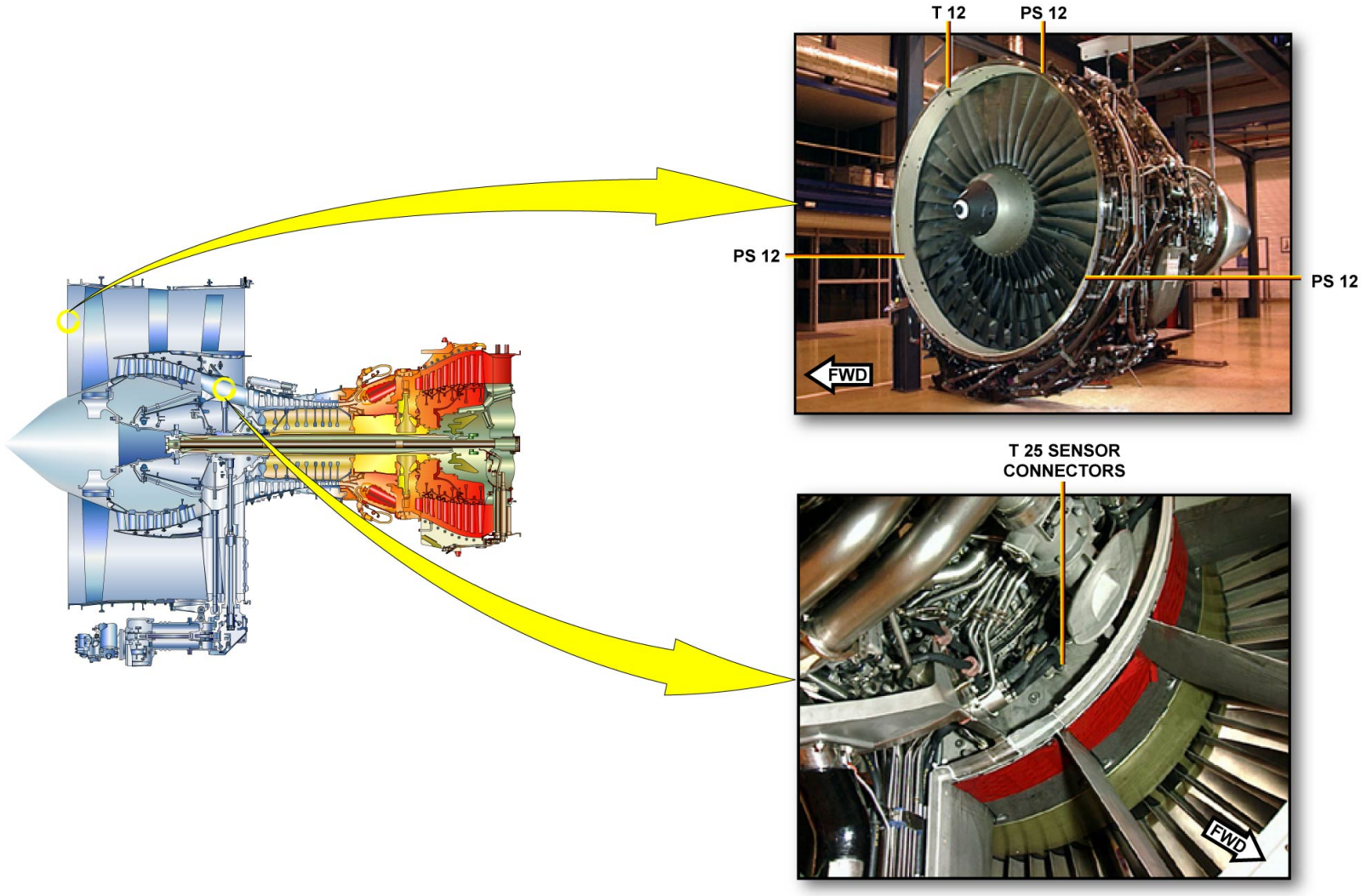
COMBUSTION AND HPT SECTION PARAMETERS DESCRIPTION

ENGINE MONITORING D/O (3)

COMPRESSOR SECTION PARAMETERS DESCRIPTION

The T12 sensor is made to measure the engine intake air temperature. It is installed on the engine fan inlet case at the 1:00 o'clock position.
The PS12 sensor measures the static pressure from the fan inlet.
The T25 sensor is located at 4:30 o'clock upstream of Variable Bleed Valve (VBV) in the fan frame. The sensor measures the air temperature downstream of the booster or HPC inlet.

UG913131 - U7RT0EC - UM77D2CFM000002



COMPRESSOR SECTION PARAMETERS DESCRIPTION

THRUST REVERSER SYSTEM PRESENTATION (2)

REVERSER DESIGN

The thrust reverser system is of the aerodynamic blockage type.
It consists of 4 pivoting blocker doors which stop and redirect fan discharge airflow.
Two doors are installed on each "C" duct.
Thrust reverser operation is possible on ground only.

HYDRAULIC SUPPLY

The thrust reverser system is hydraulically supplied by the corresponding hydraulic pump on the engine.
The thrust reverser is isolated from the hydraulic supply by a Shut Off Valve.

ACTUATION

Each door is operated by a hydraulic actuator.
The actuators receive fluid from the Hydraulic Control Unit (HCU) which is controlled by the Electronic Control Unit (ECU).
Two independent latch mechanisms maintain each pivoting blocker door in the stowed position, one inside the actuator and the second with the door latch.
The door latches are hydraulically released in series at the beginning of the deploy sequence.

REVERSER CONTROL

Basically the thrust reverser system is controlled through the ECU from the two reverser latching levers located on the throttle control levers.
The HCU has a pressurizing valve and a directional valve to select deploy or stow mode.
The directional valve is operated to deploy only.
For third defence line purposes, the Spoiler Elevator Computers (SECs) have previously opened the Shut Off Valve and the hydraulic pressure is supplied to the HCU.
Then, the Engine Interface Unit (EIU) permits reverser deployment by energization of the inhibition relay, so the directional valve can be opened by the ECU.
To command the thrust reverser, the ECU needs an "A/C on ground" signal supplied by the Landing Gear Control and Interface Units (LGCIUs).

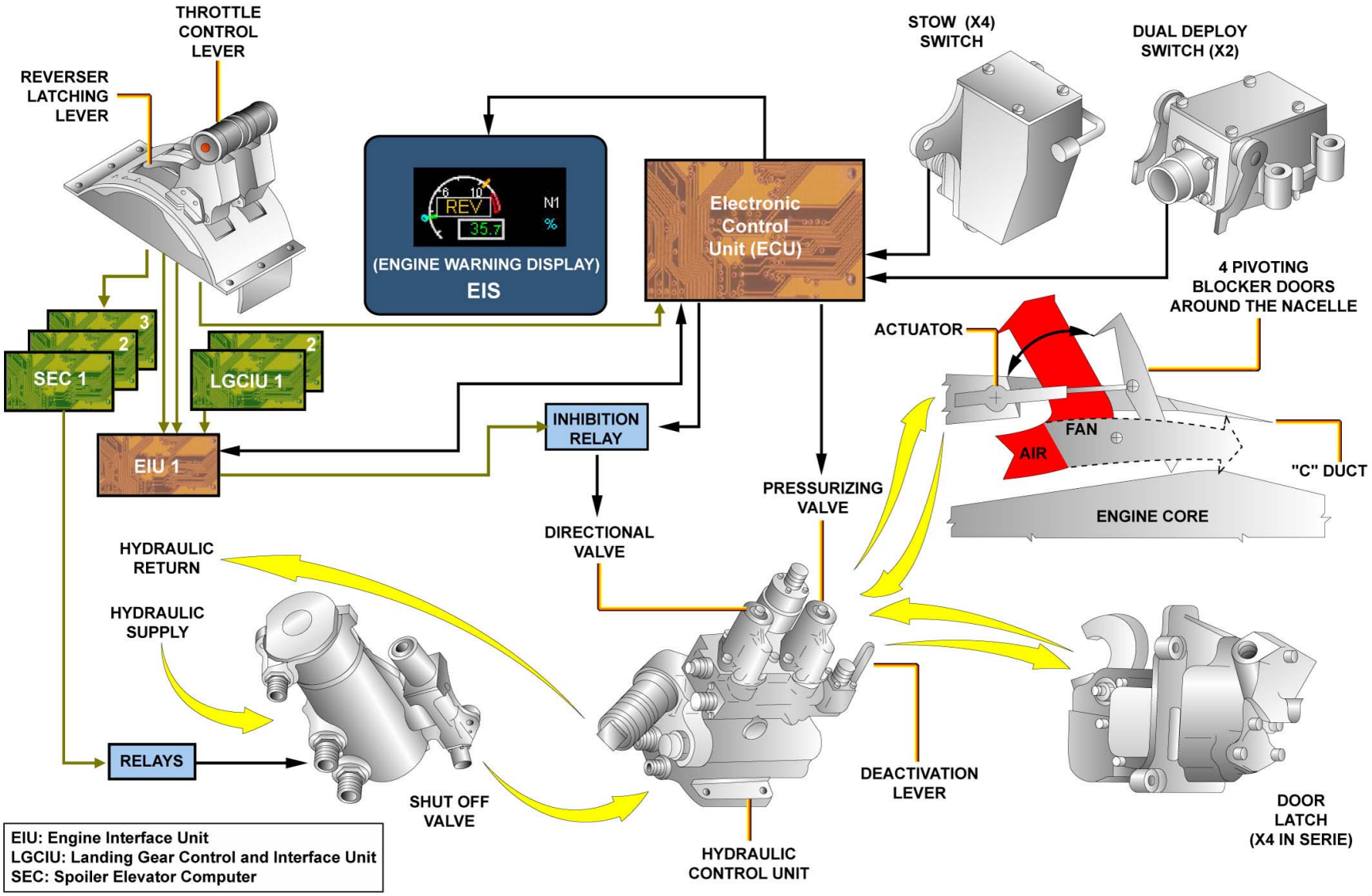
REVERSER INDICATING

The actual state of the thrust reverser is shown on the ECAM warning display (REVerser indication in the middle of N1 dial).
The signals come from the stow and deploy position switches.
Reverse thrust is allowed when reversers are deployed.

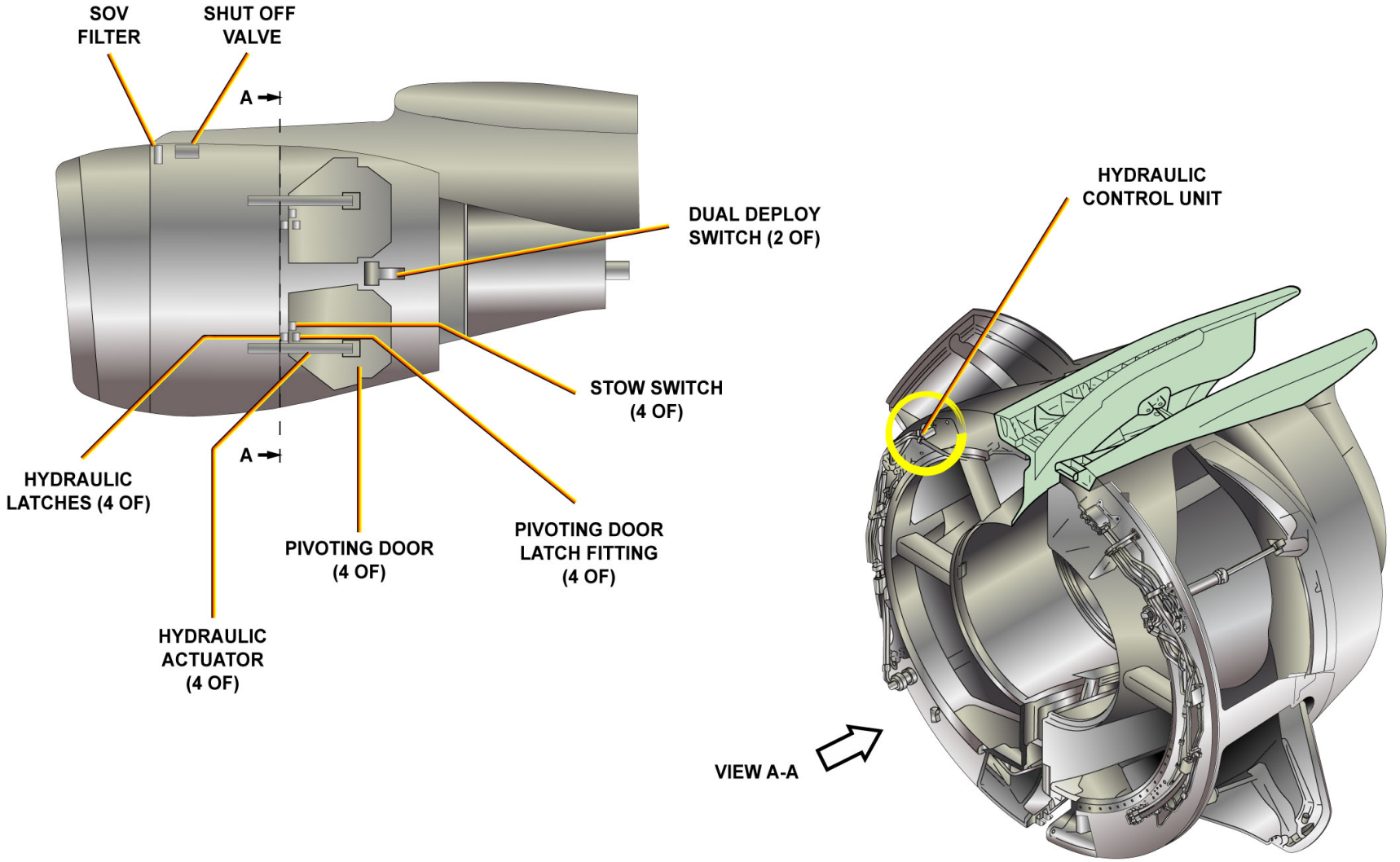
MAINTENANCE PRACTICE

To help trouble shooting, a reverser test can be performed through the MCDU.
For maintenance purposes or to increase A/C dispatch, the HCU is fitted with a deactivation lever to deactivate the thrust reverser system.
For the lock-out procedure, four lock-out bolts should also be installed.

WARNING: The thrust reverser system should be deactivated using the HCU lever, before working on the system or on the engine. If not, the thrust reverser can accidentally operate and cause serious injuries to personnel and/or damage to the reverser.



REVERSER DESIGN ... MAINTENANCE PRACTICE



REVERSER DESIGN ... MAINTENANCE PRACTICE

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UG913131 - U7RT0EC - UM78P1CFM000001

THRUST REVERSER MANAGEMENT (3)

GENERAL

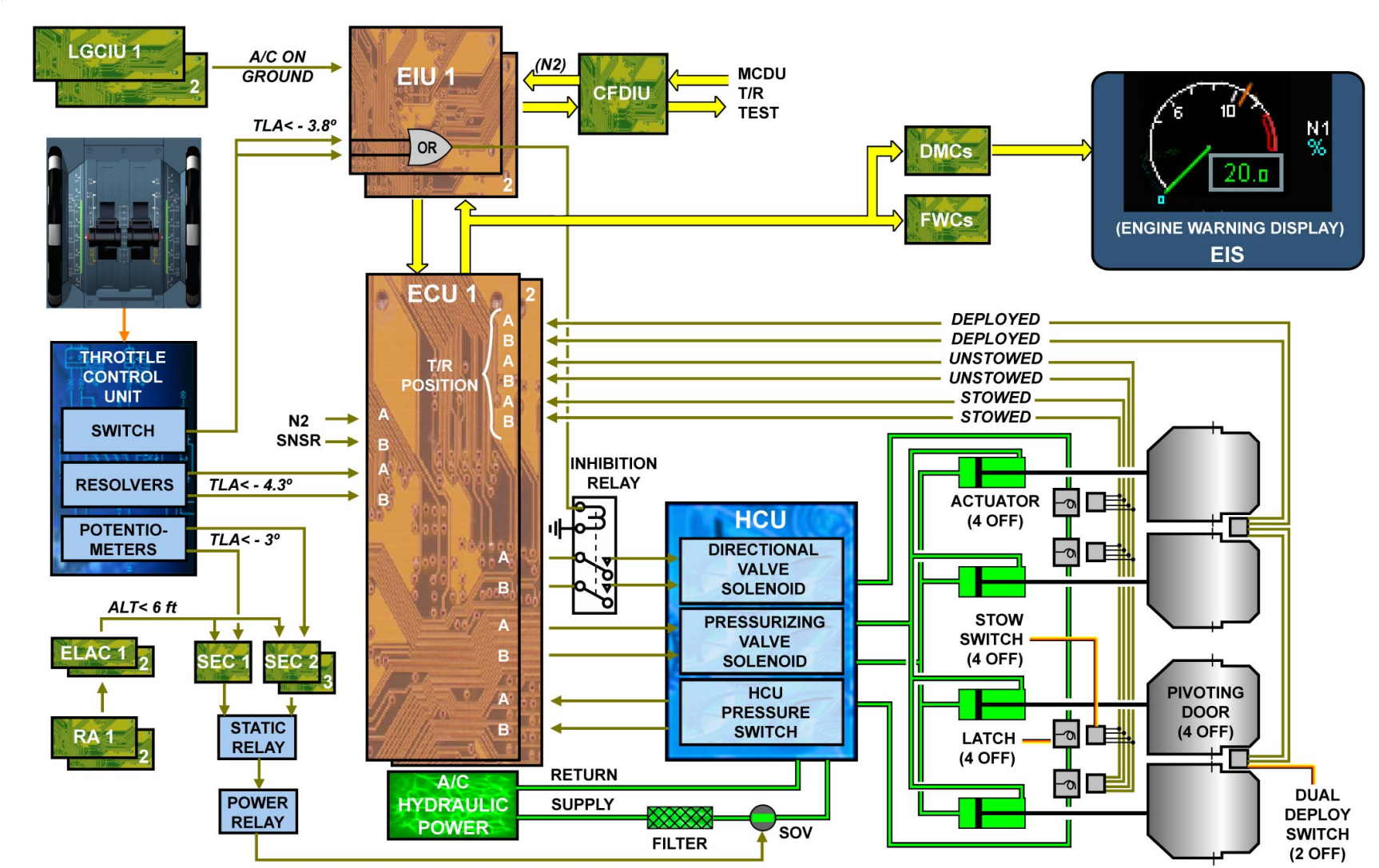
The thrust reverser system is controlled independently for each engine by the associated Full Authority Digital Engine Control (FADEC) system.

THRUST REVERSER ACTUATION

The hydraulic power required for the actuators is supplied by the normal A/C hydraulic system:
- Green system for engine 1,
- Yellow system for engine 2.

A Shut-Off Valve (SOV) located upstream of the Hydraulic Control Unit (HCU) provides an independently controlled locking system.
Each channel of the Electronic Control Unit (ECU) controls and monitors solenoid valves in the HCU. The HCU provides hydraulic pressure for unlocking, deploying, stowing and locking of the actuators and latches of the pivoting doors.
The HCU includes a pressurizing valve, a pressure switch and a directional valve which is controlled through the inhibition relay.

UG913131 - U7RT0EC - UM78D1CFM000001



GENERAL & THRUST REVERSER ACTUATION

UG913131 - U7RT0EC - UM78D1CFM000001

THRUST REVERSER MANAGEMENT (3)

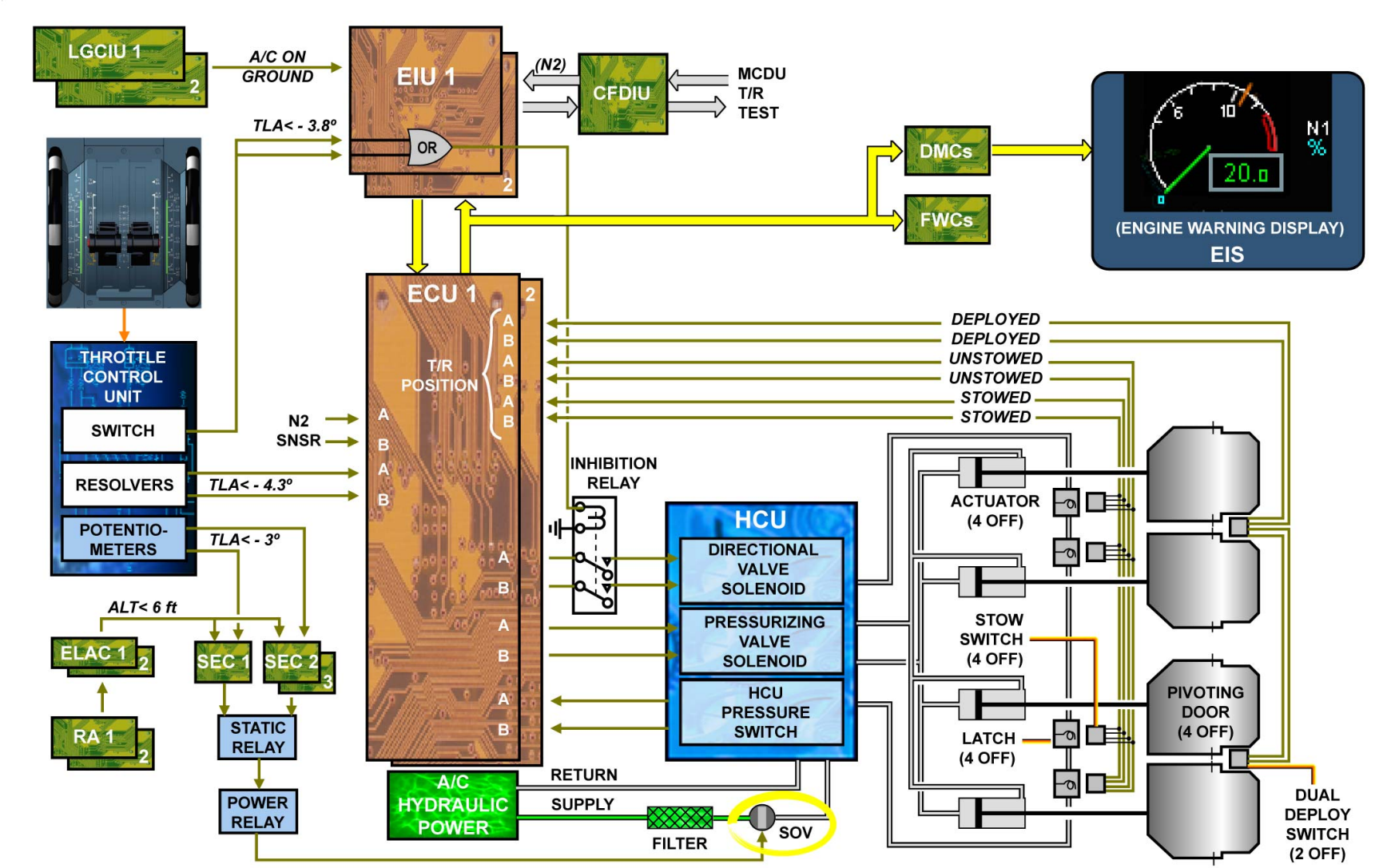
THRUST REVERSER CONTROL

When the reverse thrust is selected in the cockpit, the following sequence occurs:
- when the potentiometers detect a Throttle Lever Angle (TLA) lower than -3º, the SOV opens if the altitude is less than 6 feet and if high forward thrust is not selected on the opposite engine. Then the HCU is supplied hydraulically.
The SOV is controlled open by the Spoiler Elevator Computers (SECs) through the static and power relays.
- when the switch of the throttle control unit detects a TLA < -3.8º, the Engine Interface Unit (EIU) energizes the inhibition relay.
The ECU energizes the pressurizing valve solenoid in the HCU. A Pressure Switch in the HCU gives a feedback signal to the ECU. The four actuators are initially pressurized on the rod side of the pistons keeping the doors in the stowed position.
- When the A/C is on ground with engines running (N2 condition) and the resolvers detect a TLA < -4.3º, the ECU controls the thrust reverser operation through the HCU.
The ECU energizes the solenoid of the directional valve. The four hydraulic latches at the pivoting door open sequentially. Only when all four latches are open the hydraulic pressure pushes on the head side of the hydraulic actuators. The pivoting doors open.
When reverse thrust operation is no longer selected from the cockpit the ECU controls the pivoting doors to move to the stow position by energizing the pressurizing valve solenoid while the directional valve solenoid remains de-energized.
The stow and deploy switches are used to monitor the pivoting door position and for ECU control.

THRUST REVERSER INDICATION

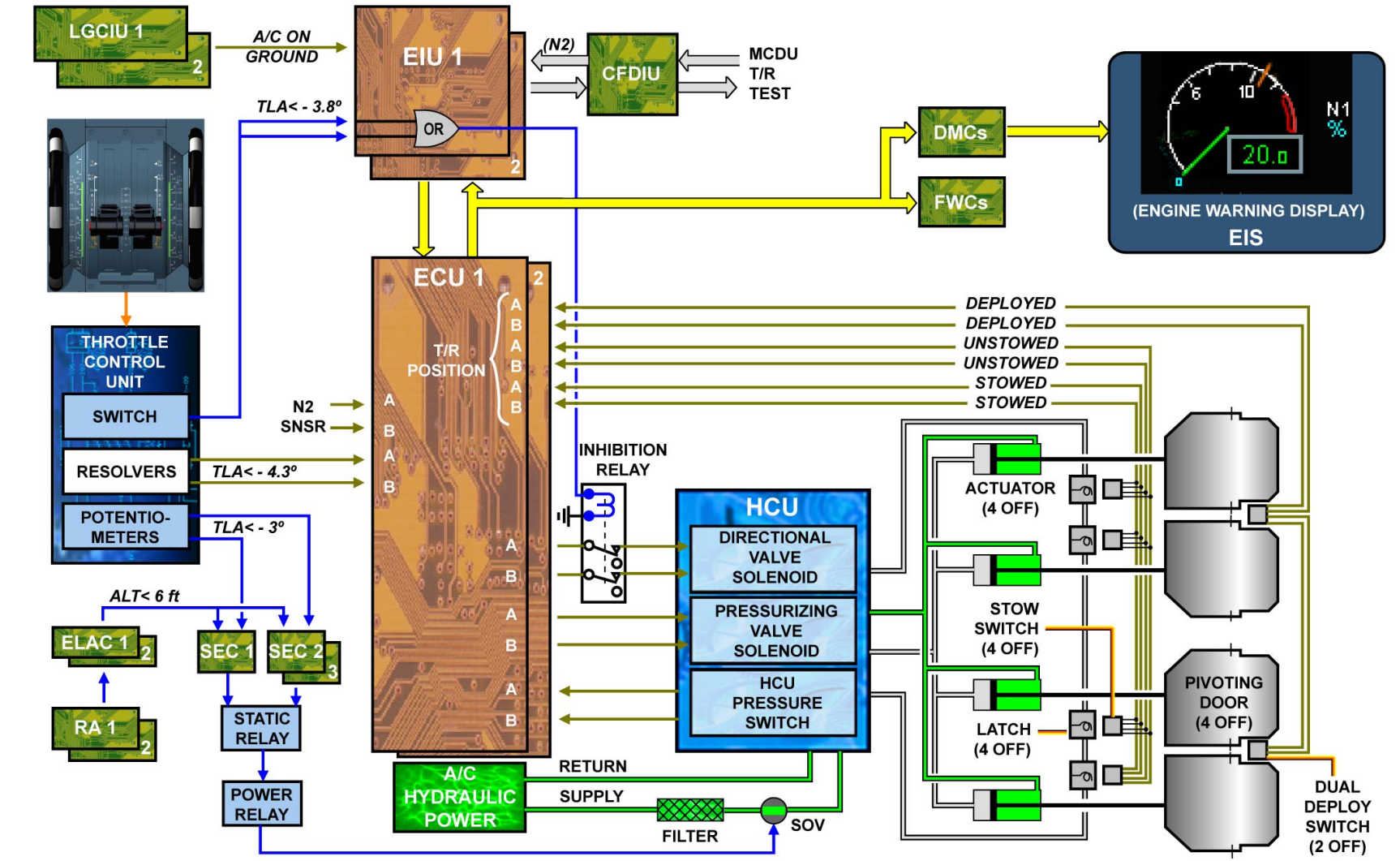
The thrust reverser operating sequences are displayed in the cockpit on the EWD.
An amber REV indication comes on on the N1 indicator when the doors are in transit. It becomes green when the doors are deployed.

NOTE: If there is a mechanical inhibition of the thrust reverser (for dispatch), a caution "ENG X REV INHIBITED" is displayed on the ECAM to tell the crew that the thrust reverser is inoperative.

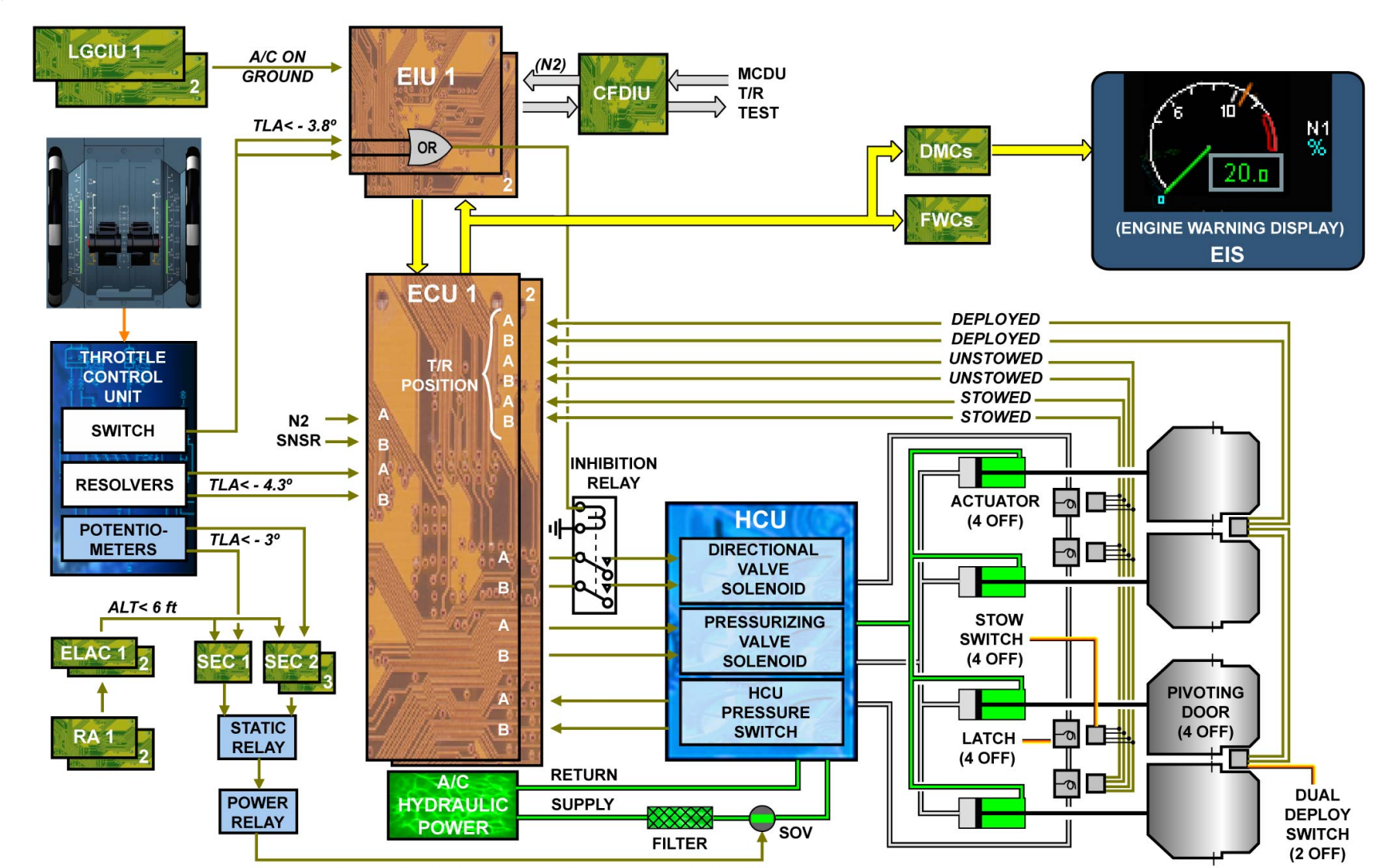


THRUST REVERSER CONTROL & THRUST REVERSER INDICATION

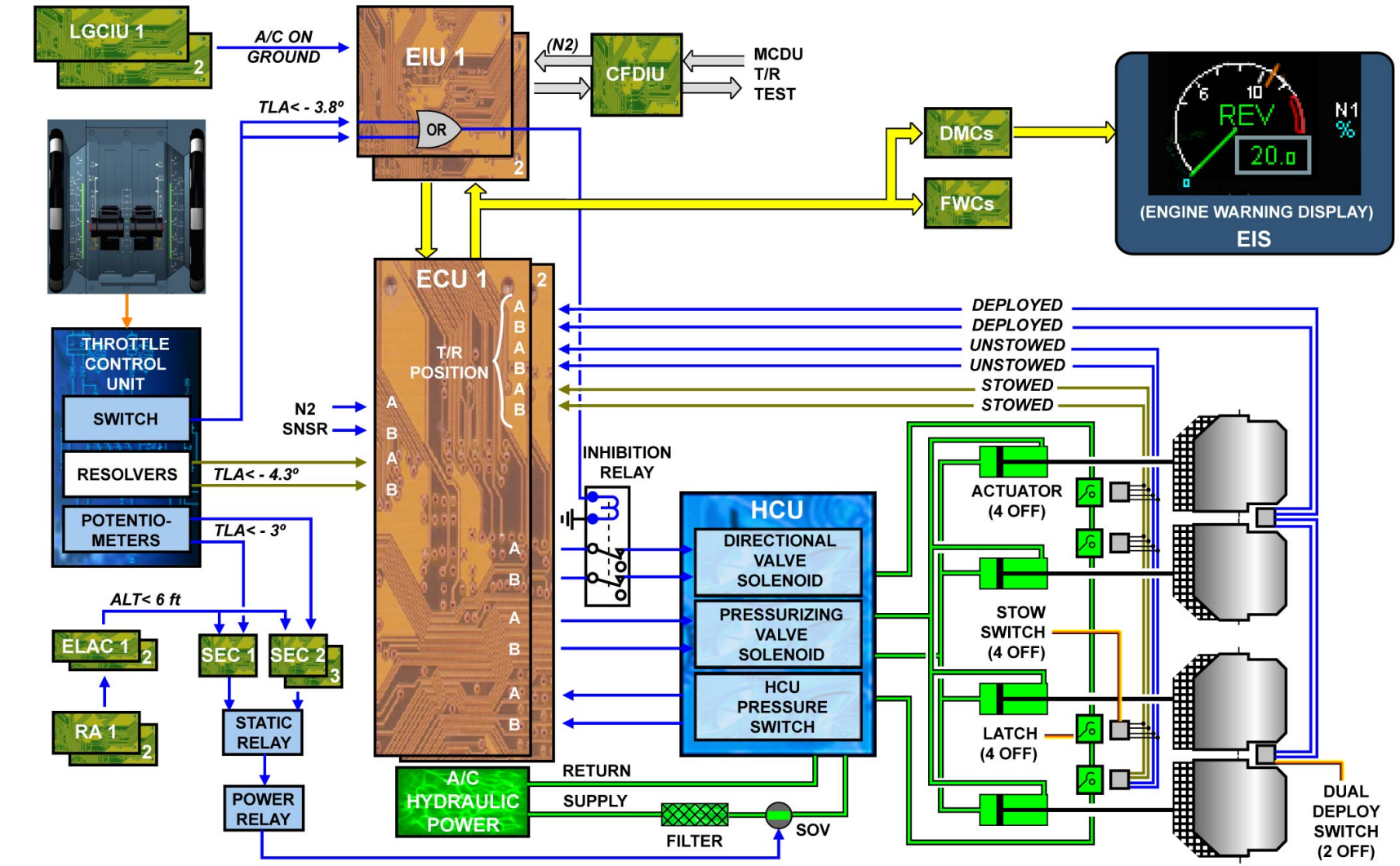
UG913131 - U7RT0EC - UM78D1CFM000001



THRUST REVERSER CONTROL & THRUST REVERSER INDICATION



THRUST REVERSER CONTROL & THRUST REVERSER INDICATION



THRUST REVERSER CONTROL & THRUST REVERSER INDICATION

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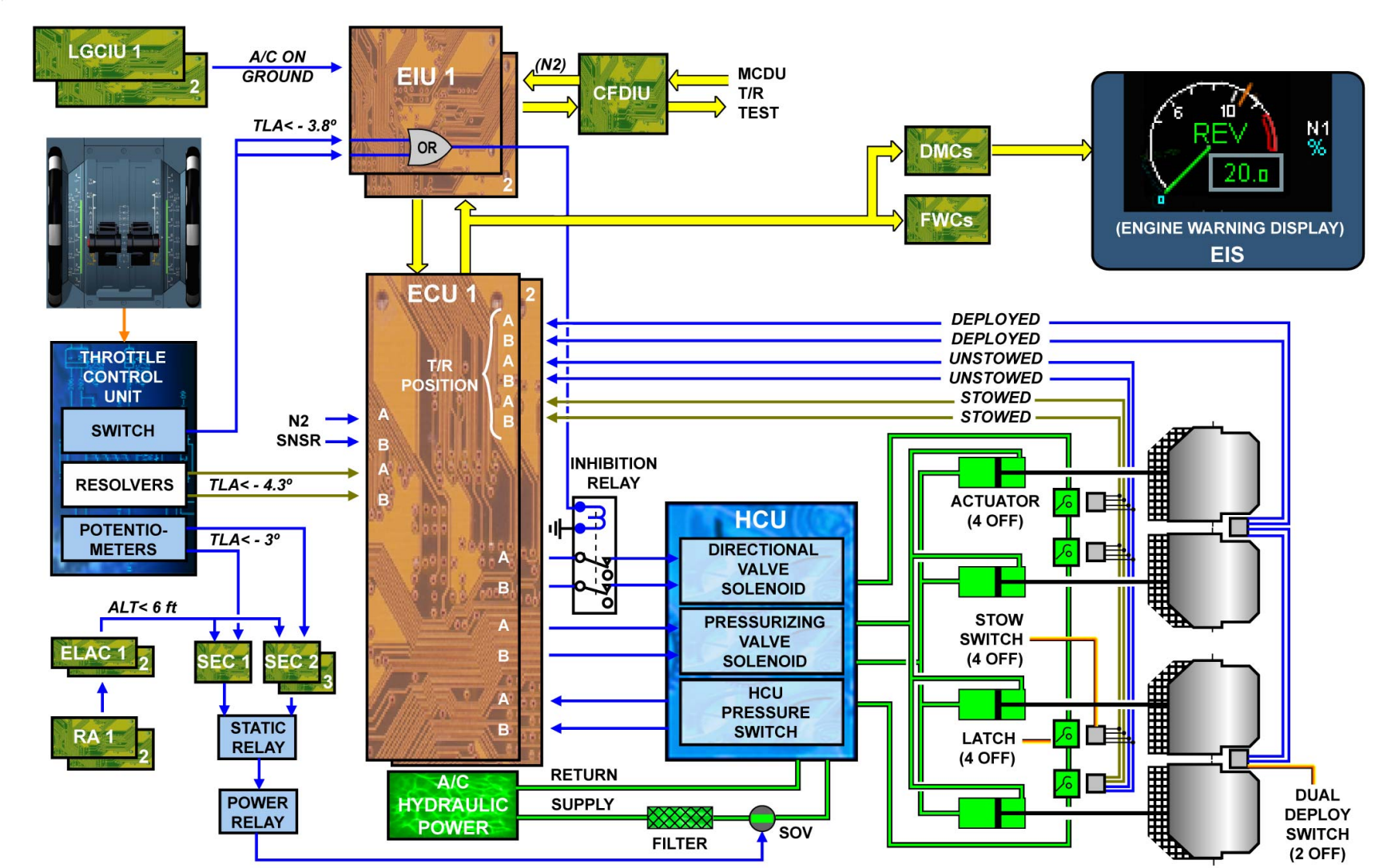
THRUST REVERSER MANAGEMENT (3)

CFDS INTERFACE

The Centralized Fault Display System (CFDS) interfaces with the EIU to provide thrust reverser fault diagnostics.
For maintenance purposes, a thrust reverser test can be performed through the MCDU menus.
During this test, the Centralized Fault Display and Interface Unit (CFDIU) simulates engine running (N2 condition) to permit the thrust reverser deployment.



CFDS INTERFACE

OIL SYSTEM D/O (3)

GENERAL

The engine oil system includes:
- a supply circuit,
- a scavenge circuit,
- a vent circuit.

It lubricates and cools the bearings of the forward and aft sumps. It also lubricates and cools bearings and gears in the transfer and accessory gearboxes.
The oil system is a "dry sump" full flow system.
A single pressure pump and four scavenge pumps of gerotor type are located in a single lubrication unit.
The major components of the oil system are the oil tank, the lubrication unit, the servo fuel heater and the main oil/fuel heat exchanger.
The detectors and sensors shown on the schematic give indicating and monitoring.

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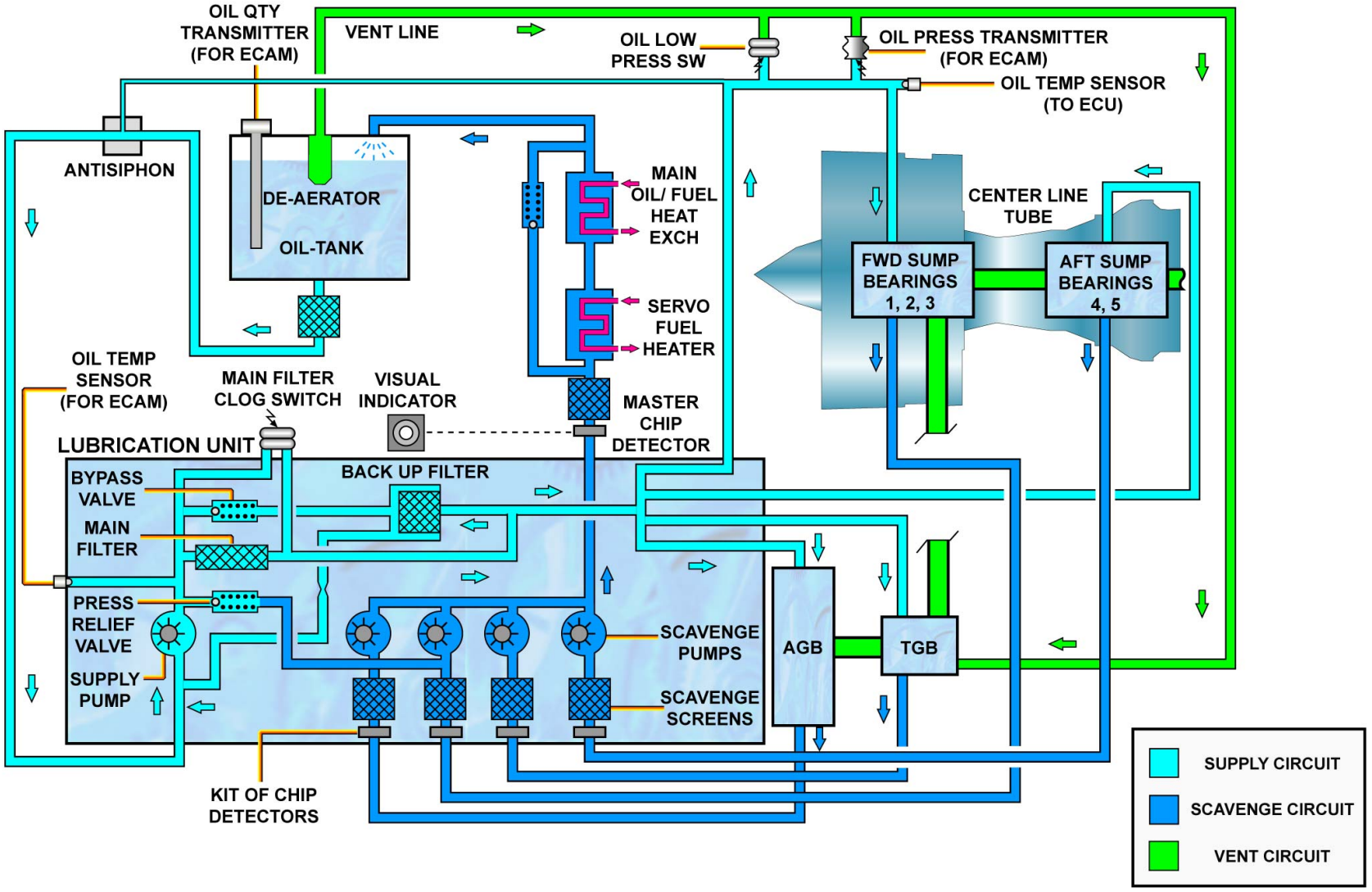
OIL QTY TRANSMITTER (FOR ECAM)
VENT LINE
OIL LOW PRESS SW
OIL PRESS TRANSMITTER (FOR ECAM)
OIL TEMP SENSOR (TO ECU)
ANTISIPHON
DE-AERATOR
OIL-TANK
MAIN OIL/ FUEL HEAT EXCH
SERVO FUEL HEATER
CENTER LINE TUBE
FWD SUMP BEARINGS 1, 2, 3
AFT SUMP BEARINGS 4, 5
OIL TEMP SENSOR (FOR ECAM)
MAIN FILTER CLOG SWITCH
VISUAL INDICATOR
MASTER CHIP DETECTOR
LUBRICATION UNIT
BACK UP FILTER
BYPASS VALVE
MAIN FILTER
PRESS RELIEF VALVE
SUPPLY PUMP
SCAVENGE PUMPS
SCAVENGE SCREENS
AGB
TGB
KIT OF CHIP DETECTORS
SUPPLY CIRCUIT
SCAVENGE CIRCUIT
VENT CIRCUIT

GENERAL

OIL SYSTEM D/O (3)

OIL SUPPLY

The oil from the tank flows through the supply pump and the main filter, or through the back up filter in case of main filter clogging.
The supply pump pressure is not controlled, but the oil output flow is, by design, always greater than the lubrication requirements.
A pressure relief valve bypasses part of the output flow to protect the supply pump against abnormal output pressure build-up.
If the main filter becomes clogged, a clog switch sends a signal to the ECAM, a bypass valve opens and the oil flows through the backup filter.
The oil flows to the forward and aft sumps, and to the accessory and transfer gearboxes.
The anti-siphon device prevents oil from draining by gravity from the tank through the pump into the gearbox after engine shutdown. It uses air from the forward sump.

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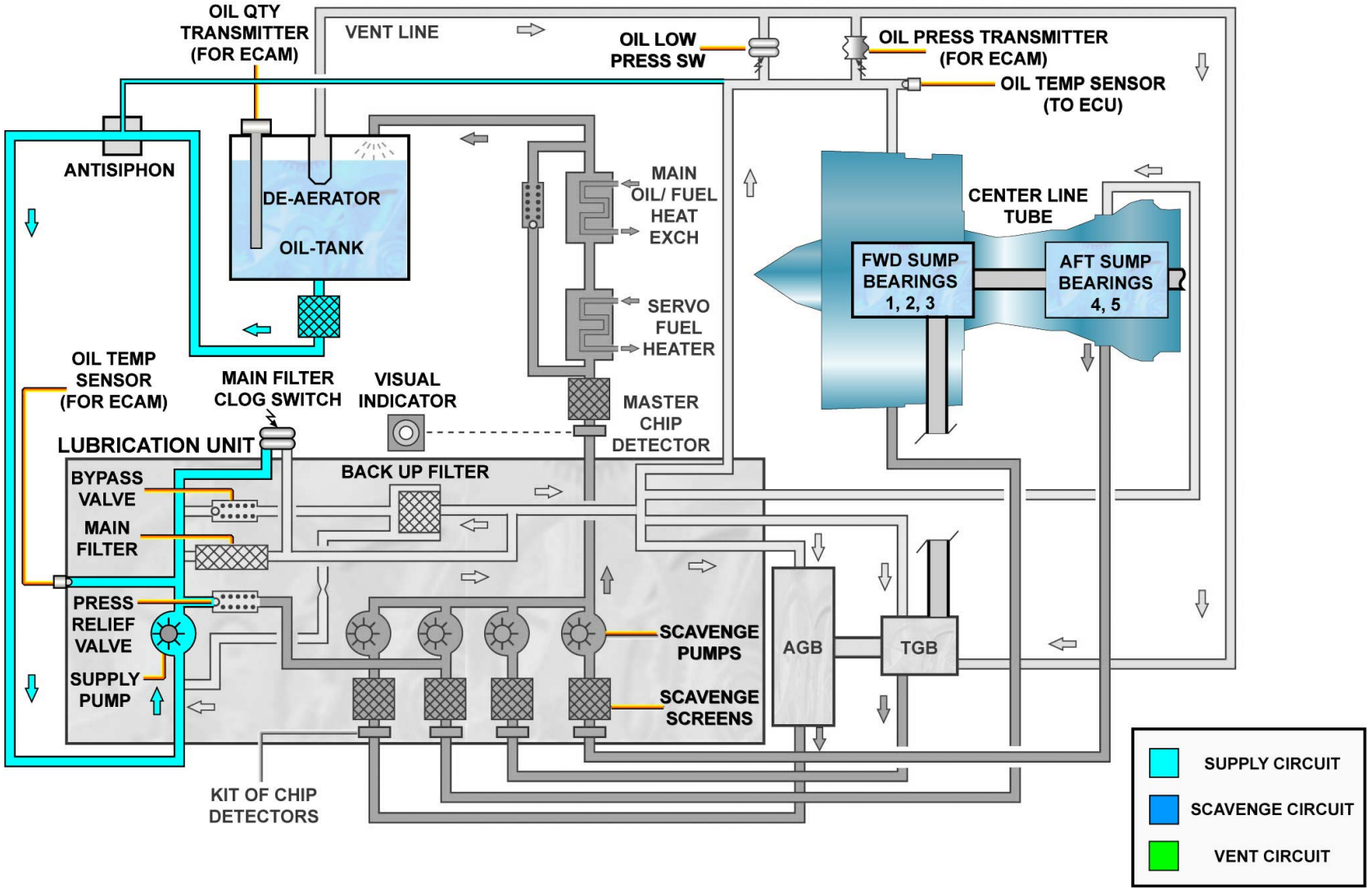
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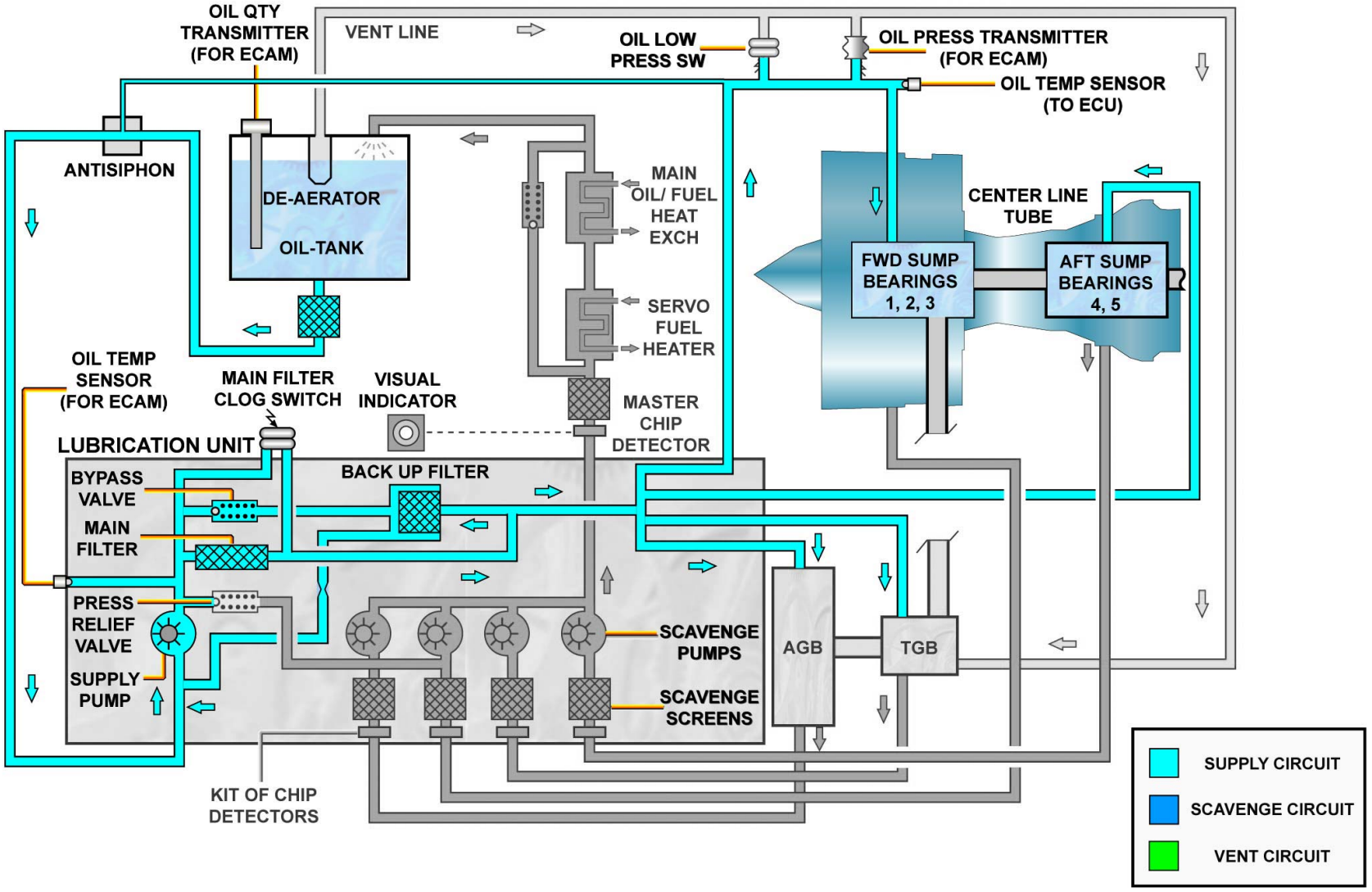
AGB
TGB
KIT OF CHIP DETECTORS
SUPPLY CIRCUIT
SCAVENGE CIRCUIT
VENT CIRCUIT

OIL SUPPLY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SCAVENGE SCREENS
AGB
TGB
KIT OF CHIP DETECTORS
SUPPLY CIRCUIT
SCAVENGE CIRCUIT
VENT CIRCUIT

OIL SUPPLY

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OIL SYSTEM D/O (3)

OIL SCAVENGE

The scavenge oil from the forward, aft sumps, and the transfer and accessory gearboxes is sucked by four scavenge pumps. A strainer protects each pump.
The scavenge oil then flows through a master chip detector, then is cooled through the servo fuel heater and the main oil/fuel heat exchanger before returning to the oil tank.
For ground inspection, the master chip detector, which is of an electrical type, has a visual indicator (pop-out) operated in case of metal particles contamination.
For trouble-shooting, a maintenance kit of 4 chip detectors may be installed on the lower part of the lubrication unit.

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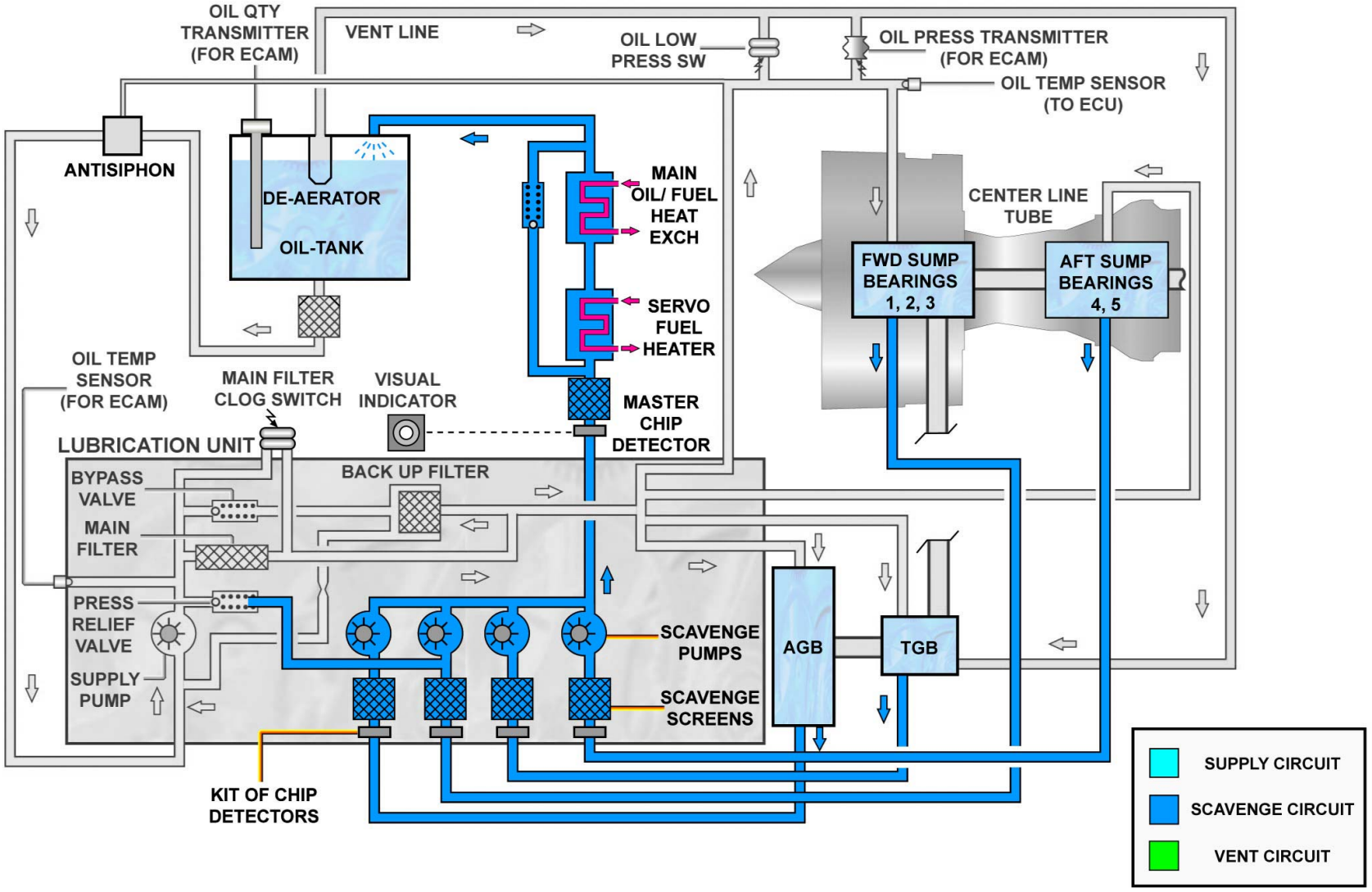
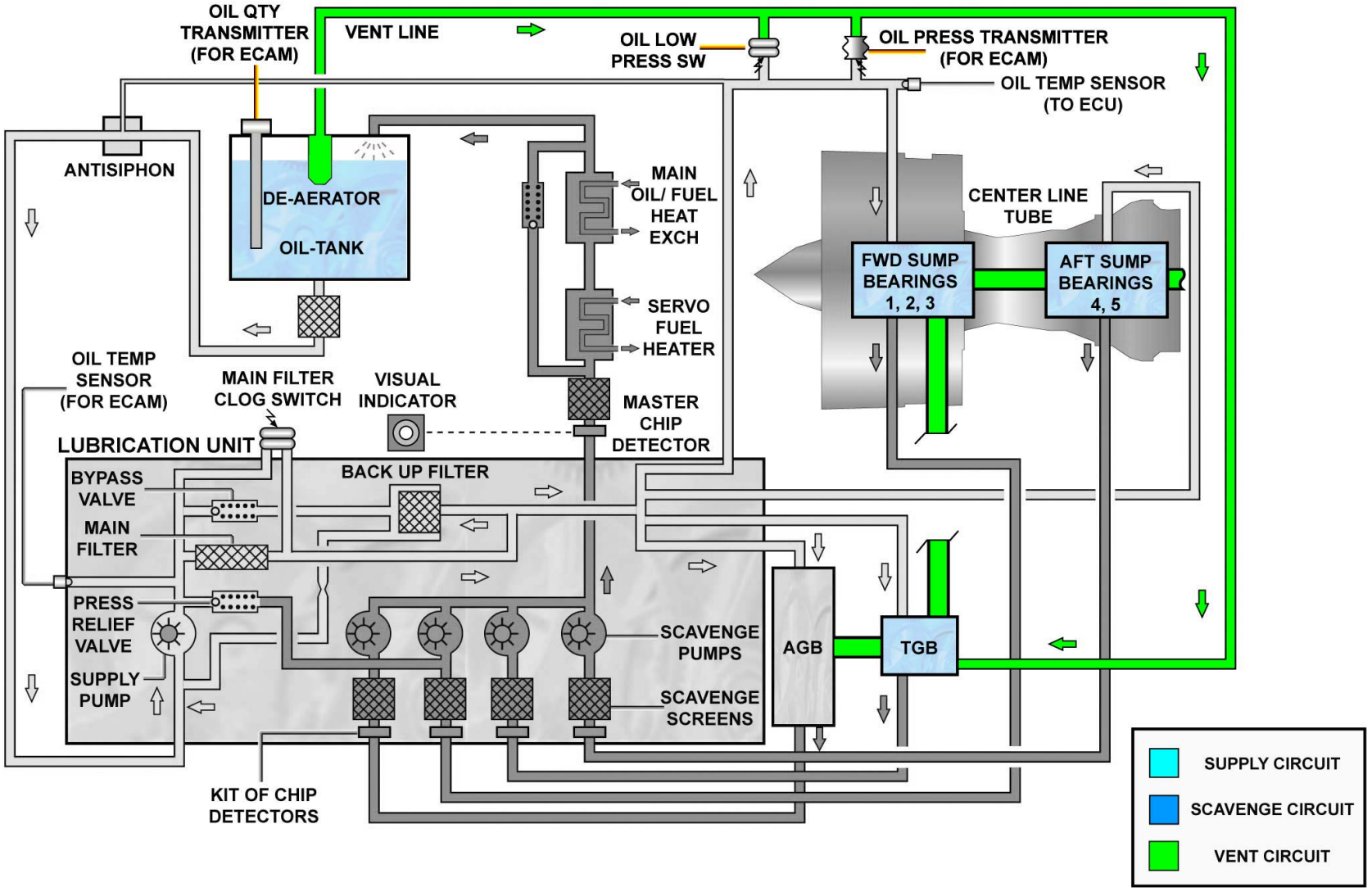


OIL SCAVENGE

OIL SYSTEM D/O (3)

OIL VENT

The venting system is in charge of connecting sumps for oil vapor collection and sumps pressure balance.
The air mixed with the scavenge oil is separated in the tank by a de-aerator and vented to the forward sump through the transfer gearbox and radial drive shaft.
The sumps are connected together by a center vent tube that vents to the outside air by the engine exhaust plug through a flame arrestor.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TGB
KIT OF CHIP DETECTORS
SUPPLY CIRCUIT
SCAVENGE CIRCUIT
VENT CIRCUIT

OIL VENT

OIL SYSTEM D/O (3)

OIL VENT (continued)

LUBRICATION UNIT INTERFACE

The lubrication unit gives the lubrication functions.
The lubrication unit supplies oil under the required pressure for lubrication of the engine bearings and gears, for scavenge of the oil after lubrication and when the oil goes back to the tank.
But, before the oil goes back to the tank, the scavenged oil from the engine sumps circulates, successively, through:
- The 4 scavenge screens (in the lubrication unit housing) which give a first and coarse filtration of the oil scavenged from the AGB, the engine forward bearing sump, the TGB and the engine aft bearing sump,
- The master magnetic chip detector (on the lubrication unit) through which circulates the total scavenged oil flow.

The lubrication unit is installed on the right-hand side of the AGB front face.
The lubrication unit has a single housing containing the following items:
- Five positive displacement pumps (one oil supply and 4 scavenge pumps),
- One oil temperature sensor,
- One clogging indicator transmitter (oil filter differential pressure switch) which sends to the cockpit a warning about main oil filter clogging, if this occurs during engine operation,
- One bypass valve for the main oil supply filter,
- One master magnetic chip detector (MCD) to detect the contamination of the engine oil system by magnetic chips/particles and connected to a master chip detector indicator.

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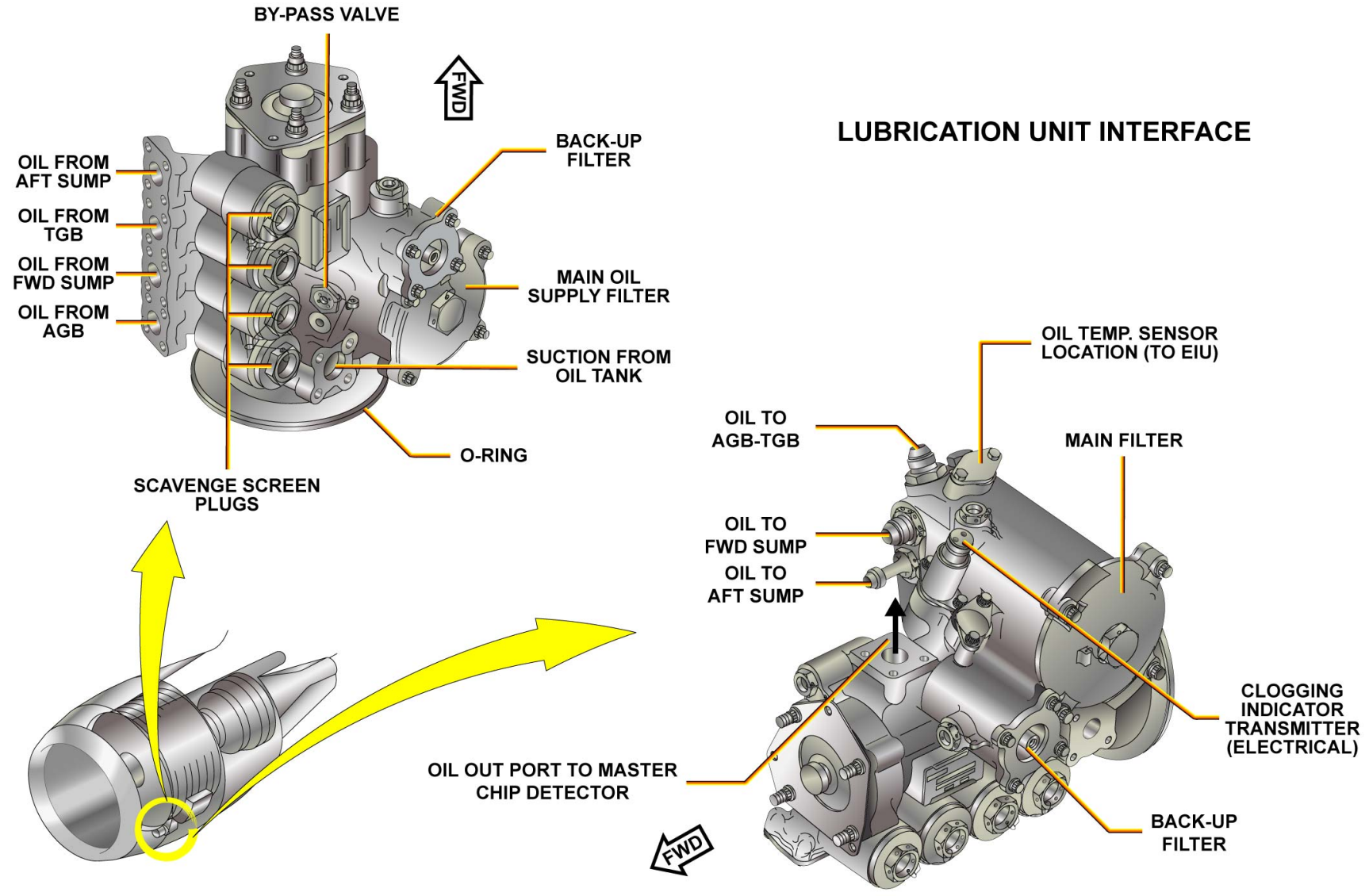

OIL VENT - LUBRICATION UNIT INTERFACE

OIL SYSTEM D/O (3)

APPROVED OILS

The engine shall be serviced only with approved oils listed in Aircraft Maintenance Manual (AMM) chapter 20.
There are no incompatibilities among same oil type. However intermixing among different brands should be avoided.

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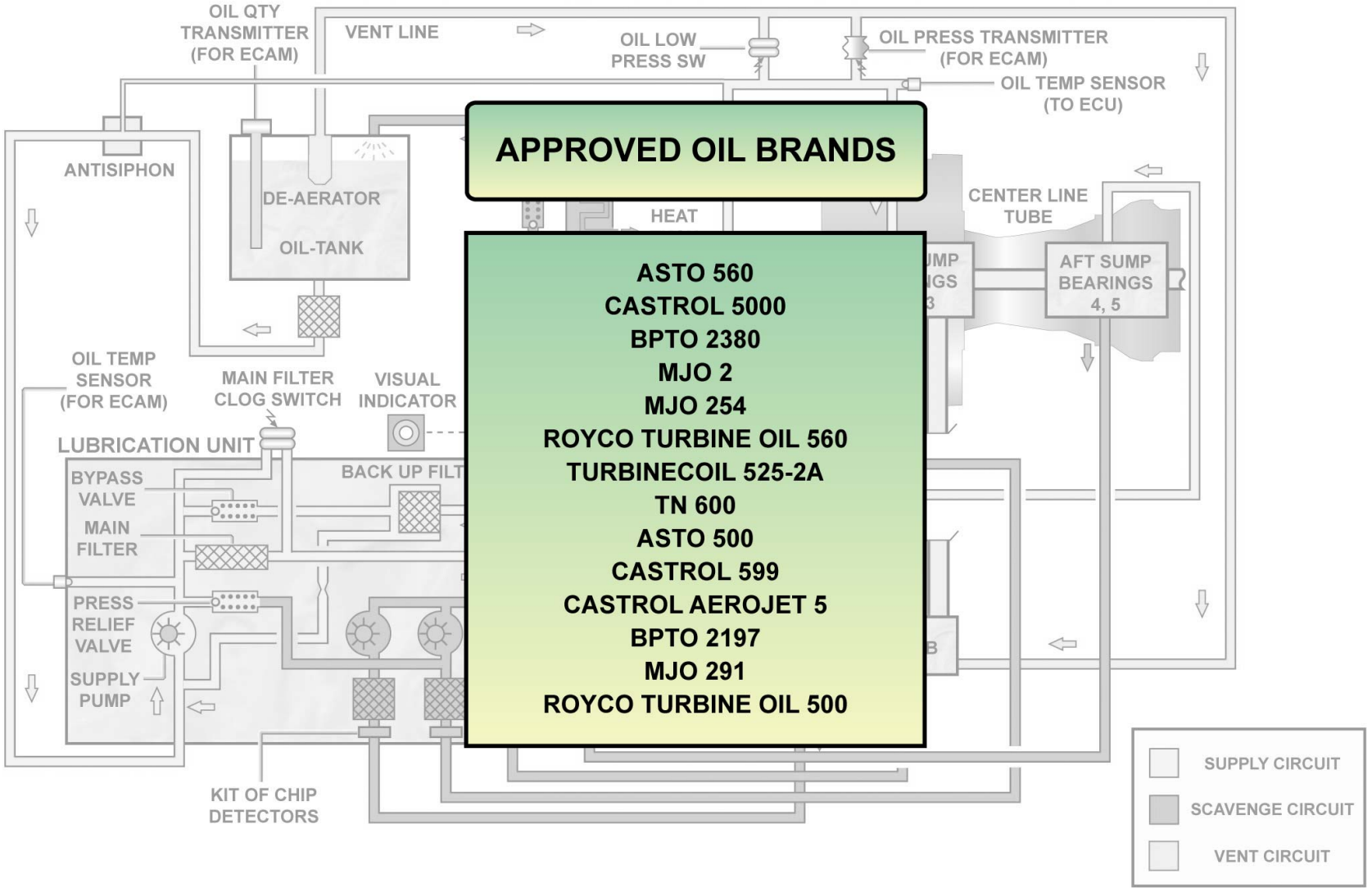

APPROVED OILS

ENGINE SYSTEM OPERATION, CONTROL & INDICATING (CFM 56) (3)

FADEC POWERING / ENGINE CONTROLS

ENG 1 HP FUEL VALVE FAULT

ENG 1 EIU FAULT

ENG 1 OIL FILTER CLOG

UG913131 - U7RT0EC - UM70IZCFMLVL302

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UG913131 - U7RT0EC - UM70IZCFMLVL302

OPENING & CLOSING OF ENGINE COWL DOORS (2)

OPENING OF THE ENGINE FAN COWL DOORS

Before working on the Engine, safety precautions have to be taken in the Cockpit.
On Panel 115 VU, put a warning notice to tell people not to start the Engines.
On the Overhead Panel, panel 50 VU, make sure that the ON legend from the FADEC Ground Power switch is off and install a warning notice.

CAUTION: Caution: Do not attempt to open the fan Cowl doors if the wind speed is higher than 96 Km/H (60 MPH).
First, unlock the three latches on the engine center Line and start with the rear latch.
For each latch, push the snaper and release the handle.
Lift and support the door by hand.
Two hold open rods are located inside the Fan Cowl door.
Move the lock rings to release the hold open rods from the stow brackets.
Extend the hold open rods and make sure that the red unlocking ring has disappeared after extension of the hold open rod.
Extend the hold open rods to hold the doors open at either the 40-degree or 55-degree position.
Attach the hold open rods to the attach brackets on the engine case.
The second half is open in the same way.

UG913131 - U7RT0EC - UM70Y2CFM000001

CAUTION

BOTH HOLD-OPEN RODS ON BOTH DOORS
MUST BE ENGAGED WHEN THE DOOR
IS OPEN.

DO NOT OPEN THE FAN COWL DOORS
IF THE WIND SPEED IS HIGHER THAN 96 Km/H (60 MPH)

OPENING OF THE ENGINE FAN COWL DOORS

OPENING & CLOSING OF ENGINE COWL DOORS (2)

OPENING OF THE ENGINE THRUST REVERSER COWL DOORS

CAUTION: Caution: Do not attempt to open the Thrust Reverser Doors if the wind speed is more than 40 knots.

First deactivate the thrust reverser system:

Push and hold the hydraulic control unit (HCU) lever to the forward frame and install the safety pin to put the thrust reverser system out of operation.

NOTE: Note: To lock the hydraulic control unit for maintenance, use a lock out pin with "red remove before flight flag" and NOT the HCU quick release pin.

Note: Before connecting the hydraulic hand pump, read the instruction written on the safety plate located nearby the quick disconnect of each thrust reverser half

On the engine center line, release the four latches.

Push the snap to free the latch handle, then pull down on the latch handle to disengage the latch hook from its attachment point.

CAUTION: Caution: Do not use a hydraulic Hand pump with a flow rate higher than the Aircraft Maintenance Manual maximum limit and make sure the hydraulic hand pump is filled with the correct oil type.

Remove the dust cover from the quick disconnect and connect the hand pump.

Make sure that the quick disconnect flexible hose tube is correctly connected to the hydraulic junction box.

Operate the hand pump to pressurize the opening actuator until the reverser half reaches the 35° position.

WARNING: Warning: Sudden closure of half doors can cause serious injury to personnel. All personnel must be clear from under and between half doors during opening and closing of the reverser.

When the door is open, remove the quick release pin that attaches the hold open rod to the upper bracket.

Move the hold-open rod from the upper bracket and attach it with the quick release pin to the bracket of the door forward frame.

WARNING: Warning: You must hold each half door open with the hold open rod to prevent serious injury due to accidental closure.

Release the pressure on the hydraulic pump and let the fluid from the actuator drain back into the hydraulic pump reservoir. Wait approximately one minute before removing the hydraulic pump flexible hose from the quick disconnect on the hydraulic junction point.

CAUTION

DO NOT OPEN THE THRUST REVERSER COWL DOORS IF THE WIND SPEED IS MORE THAN 40 KNOTS.

WARNING

MAKE THE THRUST REVERSER UNSERVICEABLE BY SECURING THE HCU LEVER IN THE INHIBITION POSITION.

OPENING OF THE ENGINE THRUST REVERSER COWL DOORS

OPENING & CLOSING OF ENGINE COWL DOORS (2)

CLOSING OF THE ENGINE THRUST REVERSER COWL DOORS

Inspect the J-Ring on the forward of the thrust reverser and the V-Groove circumference on the engine to make sure there is no excessive grease or dirt. Apply a thin coating of grease to the J-Ring and the V-Groove.
Remove the cap from the quick disconnect on the junction box.

CAUTION: Caution:
Do not use a hydraulic hand pump with a flow rate higher than the aircraft maintenance manual maximum limit and make sure the hydraulic hand pump is filled with the correct oil type.

Connect the flexible hose of the Hand Pump to the thrust reverser door quick disconnect on the hydraulic junction box.

NOTE: Note: Two hand pumps should be used, one for each side
Operate the hand pump to pressurize the opening actuator and to take the load off the hold open rod.
Disconnect the quick release pin from the bracket of the forward frame
Attach the hold-open rod to the upper or lower bracket on the adapter ring assembly with the quick release pin.

CAUTION: Caution:
Install the quick release pin with the head facing outwards to prevent damage.
Make sure the ring on the quick release pin is down. The ring rubs on the tubes. If the ring is not down it can rub on the tubes and cause damage.
Make sure while closing the reverser cowl that the cable that attaches the quick release pins (upper and lower) of the hold open rod is not trapped between the v-groove and j-ring or damage may occur to both parts.

Open the relief valve on the hand pump to let the thrust reverser door close.
Push the thrust reverser doors together to engage the door latches.
Make sure that the latch hooks on the right thrust reverser door are correctly engaged in the stirrups (eyebolts) on the left thrust reverser door.
Push each latch handle closed until it snaps over-center and the handle stays in the thrust reverser door slots.
Depressurize the hydraulic pump and let the fluid from the actuator drain back into the hydraulic pump reservoir. Wait approximately one minute before removing the hydraulic pump flexible hose from the quick disconnect on the hydraulic junction point.
Disconnect the hose of the hand pump from the quick disconnect on the hydraulic junction box.
Put the cap back on the quick disconnect.
Make the thrust reverser serviceable after maintenance by removing of the lockout pin from the hydraulic control unit (HCU) OFF position and moving the hydraulic control lever to the aft, HCU not locked position.
Make sure that the work area is clean and clear of tools or other items before removal of the access platform.

CAUTION

MAKE SURE THAT THE WORK AREA IS CLEAN AND CLEAR OF TOOLS AND OTHER ITEMS.

CLOSING OF THE ENGINE THRUST REVERSER COWL DOORS

OPENING & CLOSING OF ENGINE COWL DOORS (2)

CLOSING OF THE ENGINE FAN COWL DOORS

Support the weight of the fan cowl door.
Move the attachment lock on the rod assembly to release the hold-open rods from the attachment brackets on the engine.
Move the hold-open rod assembly away from the engine case.
Press the release lever and retract the hold-open rod assembly until the minimum extension is reached.
Attach the hold-open rods to the slow brackets located on the fan cowl door.
Make sure they lock into place on the attach brackets.
Lower the fan cowl door slowly and press them together to engage the door latches.
Close the latches and start with the front latch. Move to the middle latch and than to the rear latch.
Make sure that all the latch handles stay in the fan cowl slots and are aligned with the adjacent fan cowl surface.
Note: All the latches must be latched when the fan cowls are closed.

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CAUTION

MAKE SURE THAT THE WORK AREA IS CLEAN AND CLEAR OF TOOLS AND OTHER ITEMS.

CLOSING OF THE ENGINE FAN COWL DOORS

OPENING & CLOSING OF ENGINE COWL DOORS (2)

FAN COWL LATCHES

The fan cowl door is latched by three adjustable tension latches.
Each latch assembly consists of a snap, a handle and a hook.

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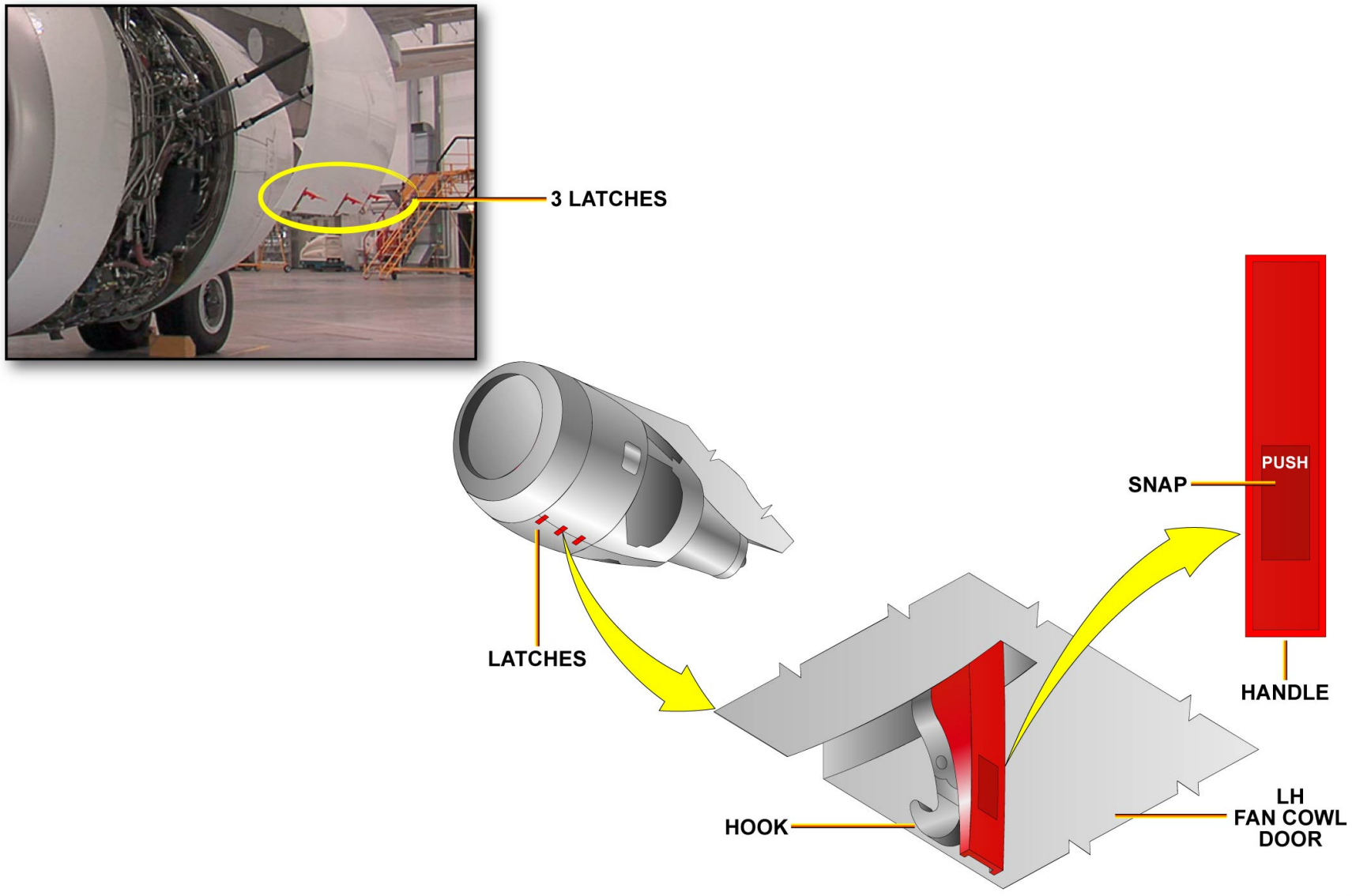

FAN COWL LATCHES

OPENING & CLOSING OF ENGINE COWL DOORS (2)

FAN COWL HOLD OPEN RODS

Two hold open rods, stored on the fan cowl doors, are extended then attached to the fan case to hold the doors.

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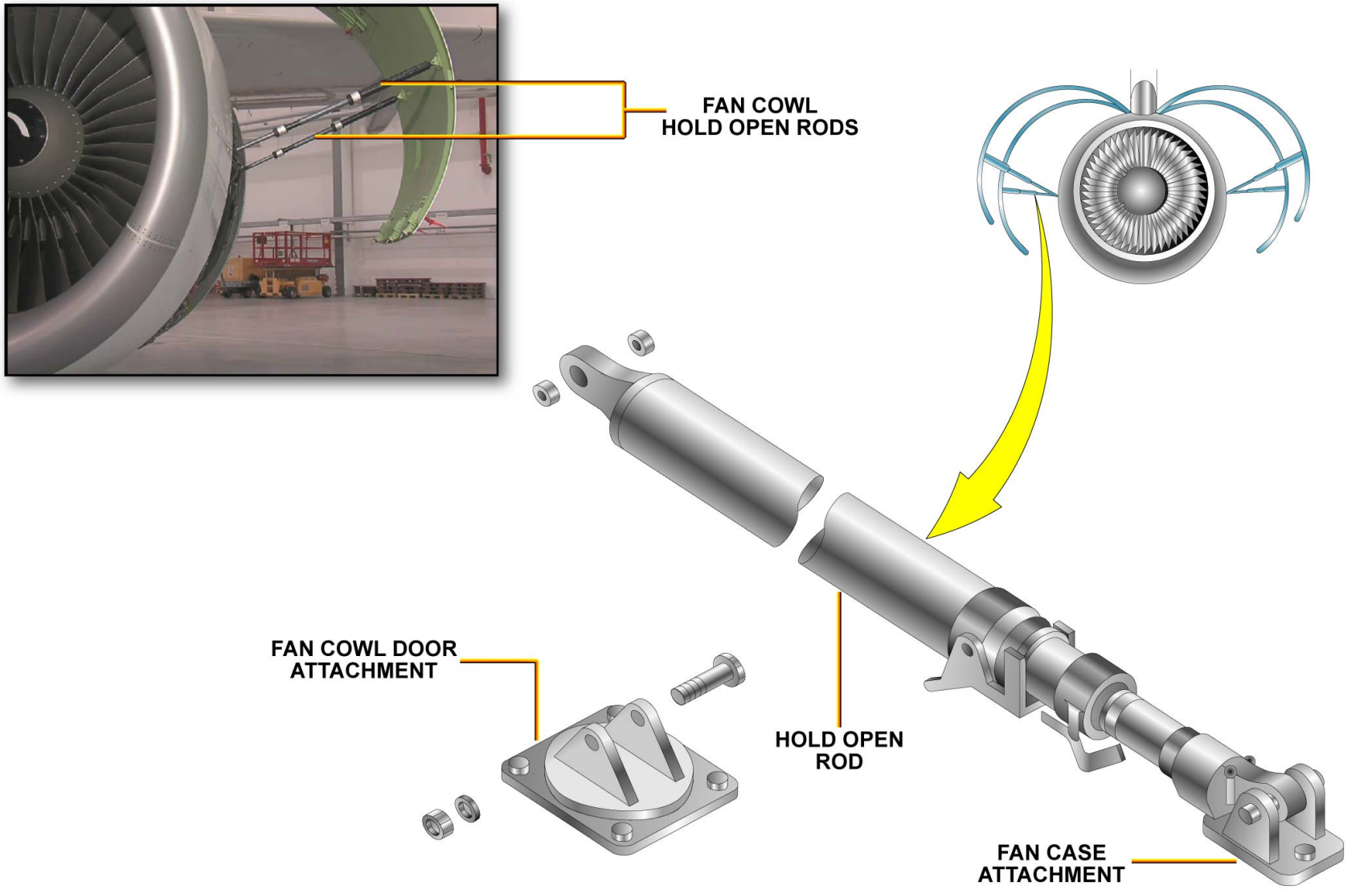

FAN COWL HOLD OPEN RODS

OPENING & CLOSING OF ENGINE COWL DOORS (2)

THRUST REVERSER COWL LATCHES

Four adjustable tension latches are provided on the thrust reverser cowling assembly.
Each latch is unlocked by pushing a snap on its handle to disengage the corresponding hook from its bracket.

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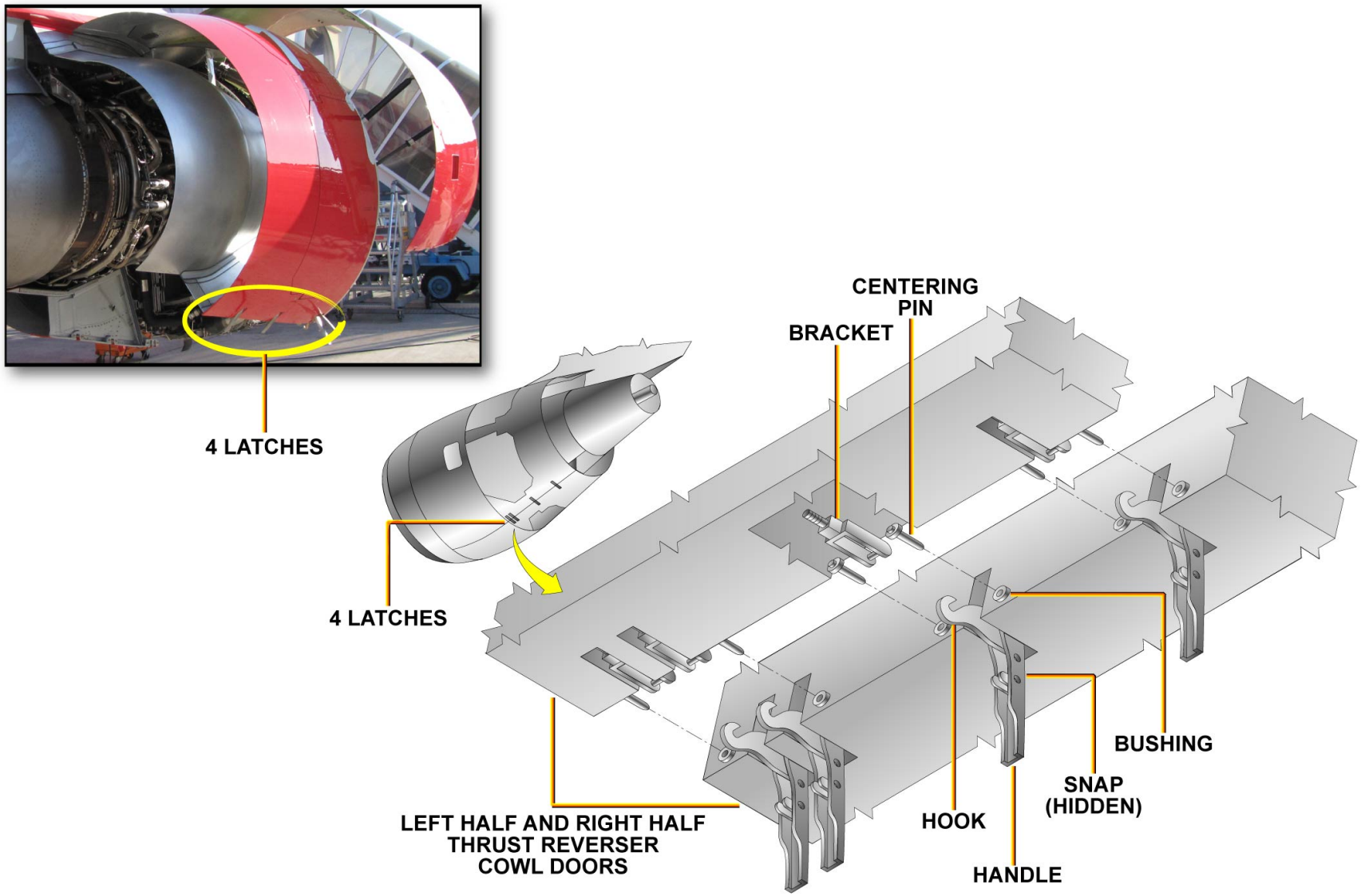

THRUST REVERSER COWL LATCHES

OPENING & CLOSING OF ENGINE COWL DOORS (2)

INSTRUCTION PLATE

Beside each quick disconnect for the hand pump, an instruction plate is installed to warn against extension of slats during thrust reverser cowl door opening.

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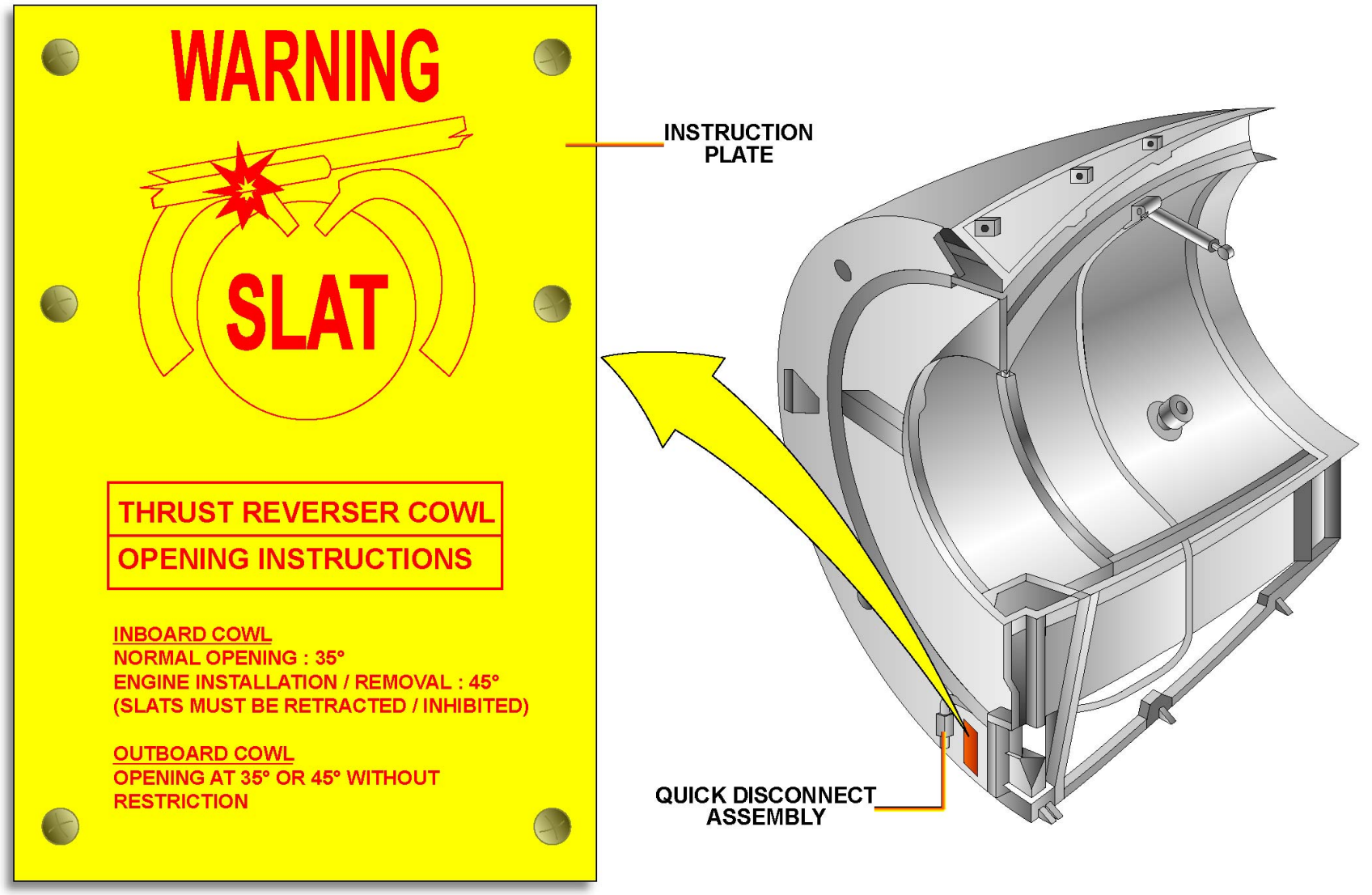

INSTRUCTION PLATE

OPENING & CLOSING OF ENGINE COWL DOORS (2)

THRUST REVERSER COWL QUICK DISCONNECT

Each thrust reverser cowl door is fitted with a quick disconnect to connect a hand pump.

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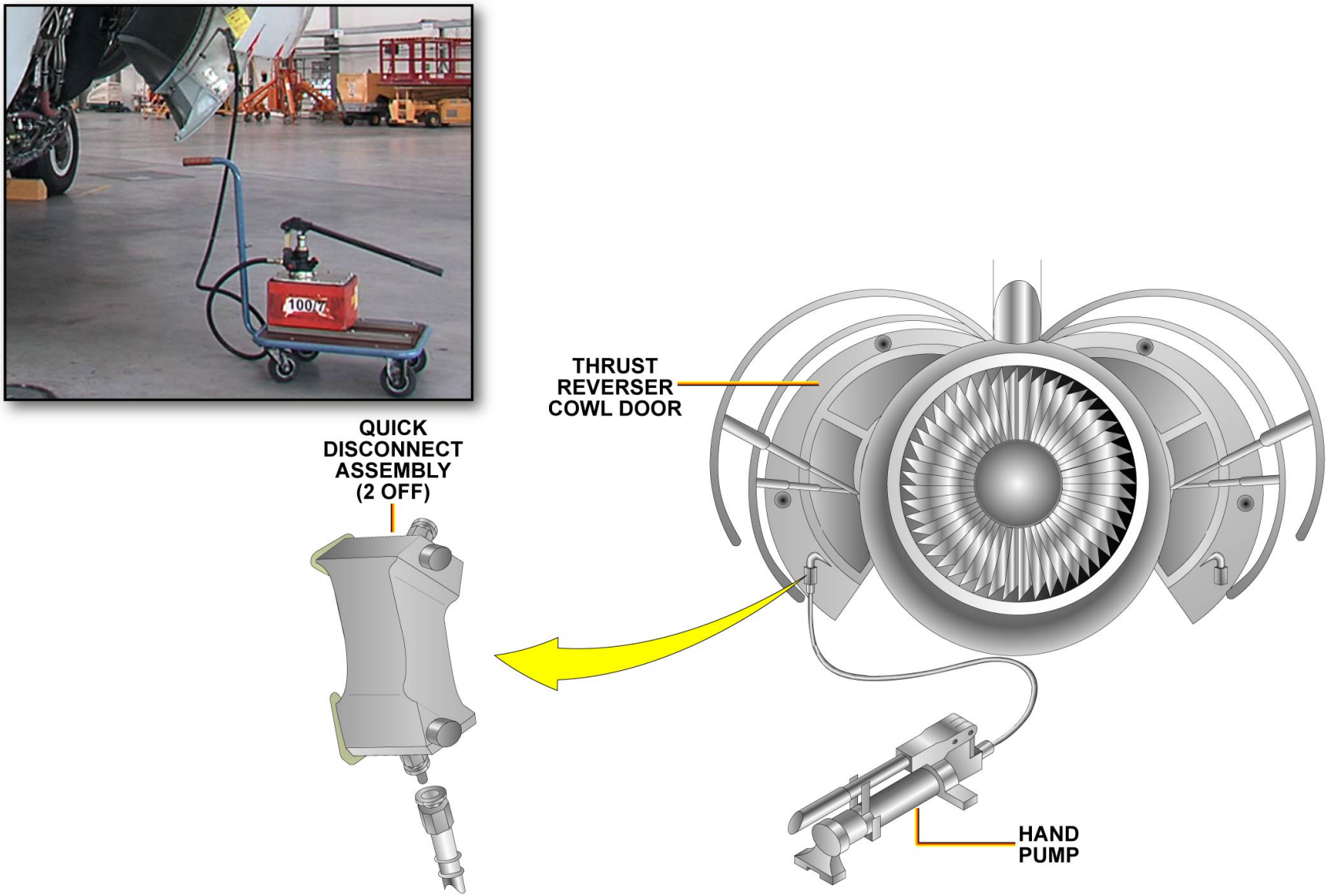

THRUST REVERSER COWL QUICK DISCONNECT

OPENING & CLOSING OF ENGINE COWL DOORS (2)

THRUST REVERSER COWL OPENING ACTUATOR

To open each thrust reverser cowl door, an actuator is extended by hydraulic pressure from the hand pump.

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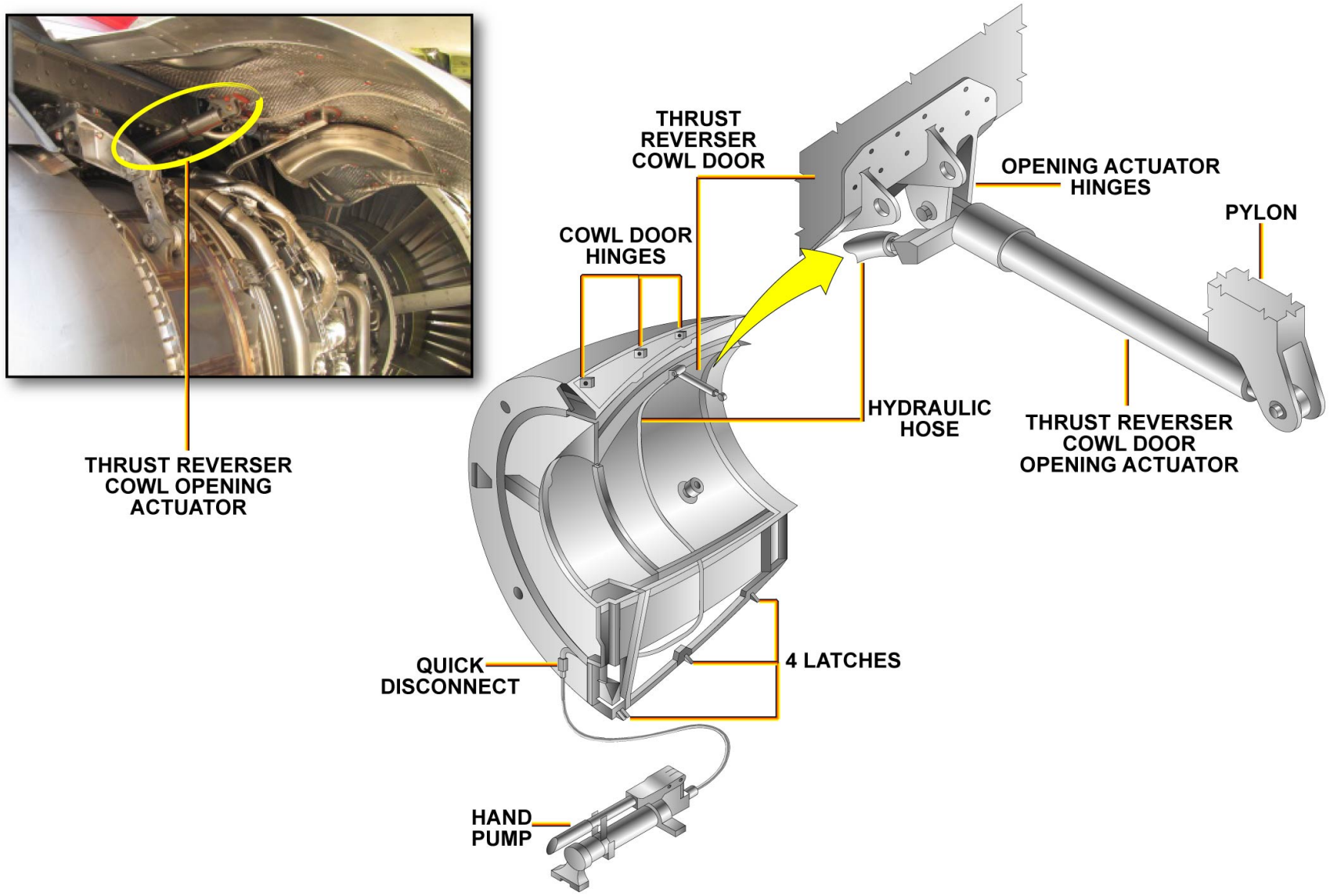


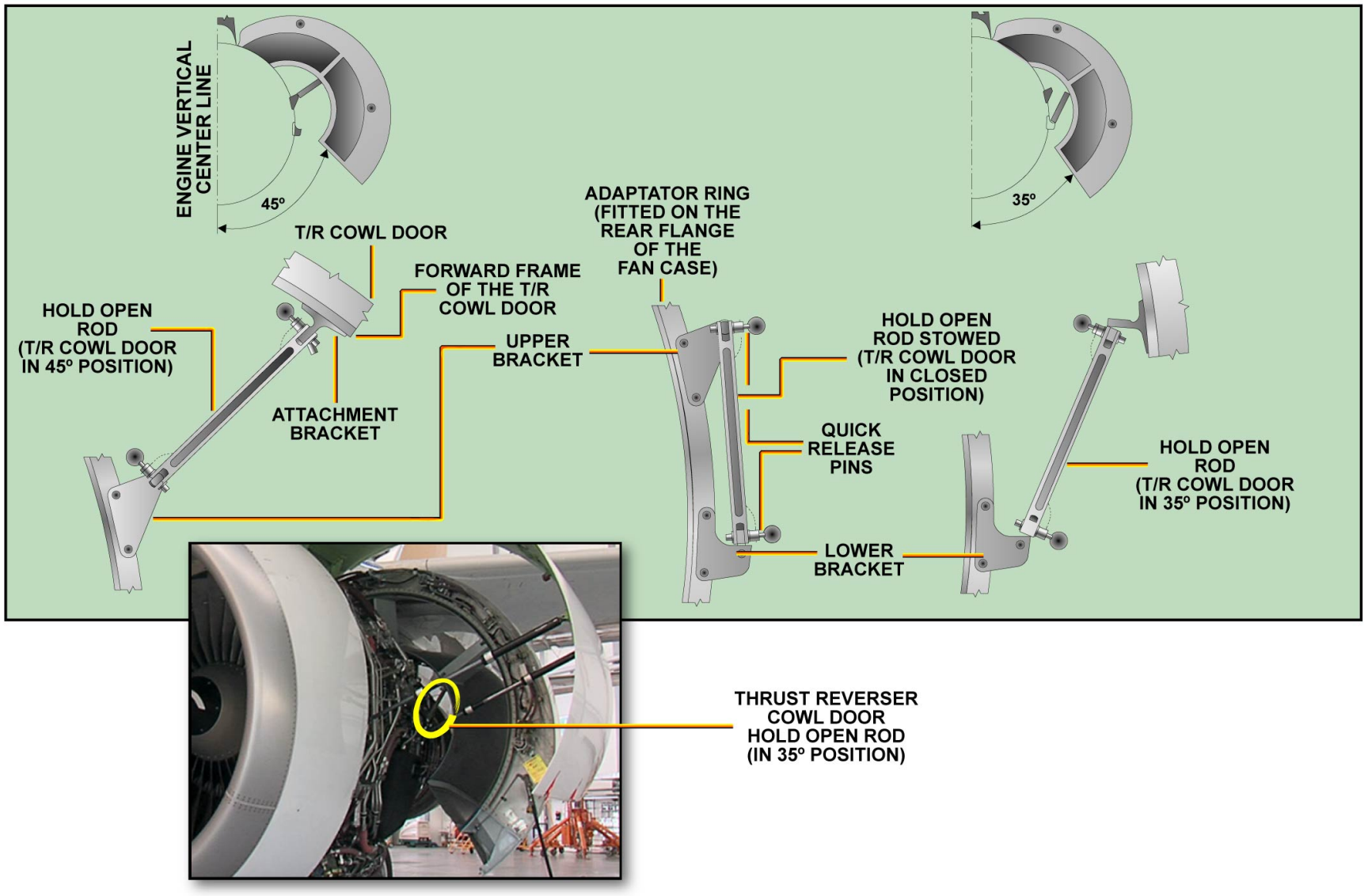
THRUST REVERSER COWL OPENING ACTUATOR

OPENING & CLOSING OF ENGINE COWL DOORS (2)

THRUST REVERSER COWL HOLD OPEN ROD

Only one hold open rod keeps each thrust reverser cowl door in the open position.
The hold open rod is stored on the fan case then extended and attached to the thrust reverser cowl door.

UG913131 - U7RT0EC - UM70Y2CFM000001


ENGINE VERTICAL CENTER LINE
45°
T/R COWL DOOR
FORWARD FRAME OF THE T/R COWL DOOR
HOLD OPEN ROD (T/R COWL DOOR IN 45° POSITION)
ATTACHMENT BRACKET
UPPER BRACKET
ADAPTATOR RING (FITTED ON THE REAR FLANGE OF THE FAN CASE)
HOLD OPEN ROD STOWED (T/R COWL DOOR IN CLOSED POSITION)
QUICK RELEASE PINS
LOWER BRACKET
35°
HOLD OPEN ROD (T/R COWL DOOR IN 35° POSITION)
THRUST REVERSER COWL DOOR HOLD OPEN ROD (IN 35° POSITION)

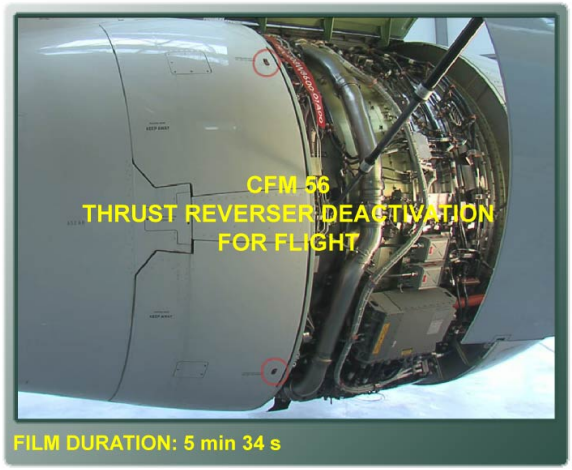
THRUST REVERSER COWL HOLD OPEN ROD

THRUST REVERSER DEACTIVATION & LOCKOUT (2)

THRUST REVERSER DEACTIVATION AND LOCKOUT

This procedure is carried out when a fault occurs on the thrust reverser system which can not be repaired for the next flight. Deactivation and lockout devices are therefore provided to secure the pivoting doors in their stowed position when an aircraft has to be dispatched with an inoperative thrust reverser.
Before working on the engine safety precautions have to be taken in the cockpit.
On Panel 115 VU put a warning notice to tell people not to start the engines.
On the Overhead Panel, panel 50 VU, make sure that the on legend from the FADEC Ground Power switch is off and install a warning notice.
Open the fan cowl doors and put the access platform into position
Make the Thrust reverser unserviceable by removing the quick release pin from the stowage position on the HCU, move the inhibition lever to the OFF position and insert the quick release pin.
Do an operational test of the thrust reverser system with the CFDS in accordance to the AMM.
Energize the related ECU with the FADEC Ground Power Pushbutton Switch on panel 50VU.
Get access to the CFDS System Report Test, select next page and select the line key next to engine. Select the line key related to the FADEC 1A or 1B menu to get access to the System Test and Reverser Test menu.
Obey the cautions and warnings in the AMM and on the MCDU before you start the Reverser Test to prevent any injury to personnel or damage to equipment.
Make sure that the green or amber REV indication does not appear in the N1 indication on the engine and warning display. Check that the ECAM warning Engine 1 or Engine 2 reverser fault appears. Make sure that none of the following messages appear on the test report after the test :
"DEPL SW, J5/J6, ECU"
"STOW SW, J5/J6, ECU"
"DPLSTW SW, J5/J6, ECU"
"EIU, HCU or TR LOCK, TR ACT"
"HCU (TRPV), HYD or HCU, TRSOV, HYD"
Remove the screw that attaches the lockout fairing to the pivoting blocker door.
Remove the bolt that attaches the lock-plate from the stowage bracket and remove the lock-plate.
Remove the lockout bolt from the stowage bracket.
Install the lockout bolt on the pivoting blocker door and torque it correctly in accordance to the values mentioned in the AMM.
Put the lock-plate over the lockout bolt and install the smaller bolt. Torque it correctly in accordance to the values in the AMM.
Attach the lockout fairing to the stowage bracket and torque the screw correctly in accordance to the values in the AMM.
Repeat this procedure with all pivoting blocker doors at the related engine
Make sure that the working area is clean and clear of tools. Remove the access platform and close the fan cowl doors.
Remove the warning notices in the cockpit.
Do a FADEC ground test (engine non motoring). Make sure that the following fault messages are not shown :
"DEPL SW, J5/J6, ECU"
"STOW SW, J5/J6, ECU"
"DPLSTW SW, J5/J6, ECU"
In the cockpit install a warning notice to show that the thrust reverser is inoperative. Make an entry into the logbook.
This completes the Thrust Reverser deactivation procedure for flight operation.

UG913131 - U7RT0EC - UM70Y3CFM000001



THRUST REVERSER DEACTIVATION AND LOCKOUT

THRUST REVERSER DEACTIVATION & LOCKOUT (2)

THRUST REVERSER DEACTIVATION LEVER

To deactivate the thrust reverser system, the safety pin is installed to hold the deactivation lever in the inhibition position.

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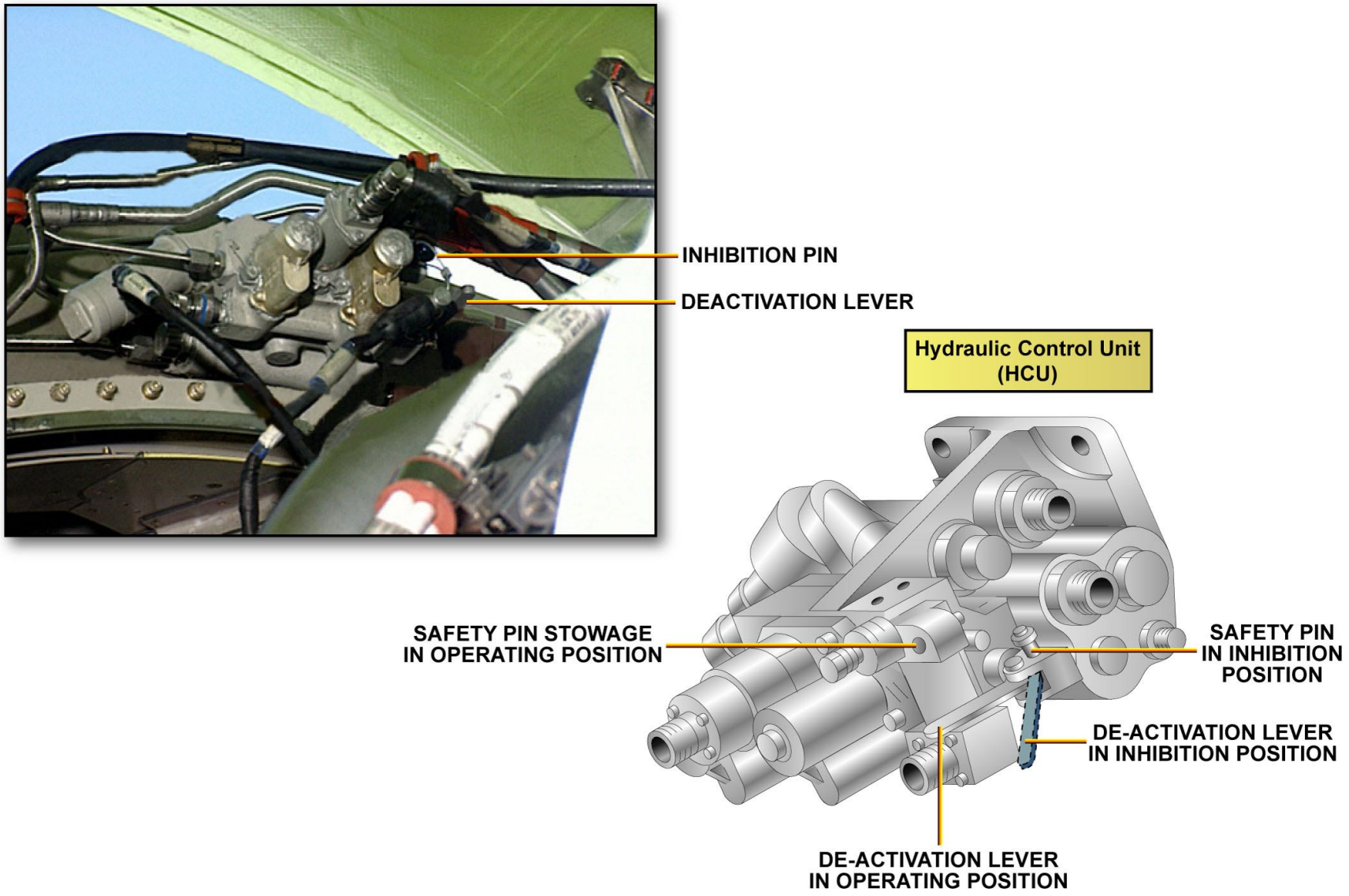

INHIBITION PIN
DEACTIVATION LEVER
Hydraulic Control Unit (HCU)
SAFETY PIN STOWAGE IN OPERATING POSITION
SAFETY PIN IN INHIBITION POSITION
DE-ACTIVATION LEVER IN INHIBITION POSITION
DE-ACTIVATION LEVER IN OPERATING POSITION

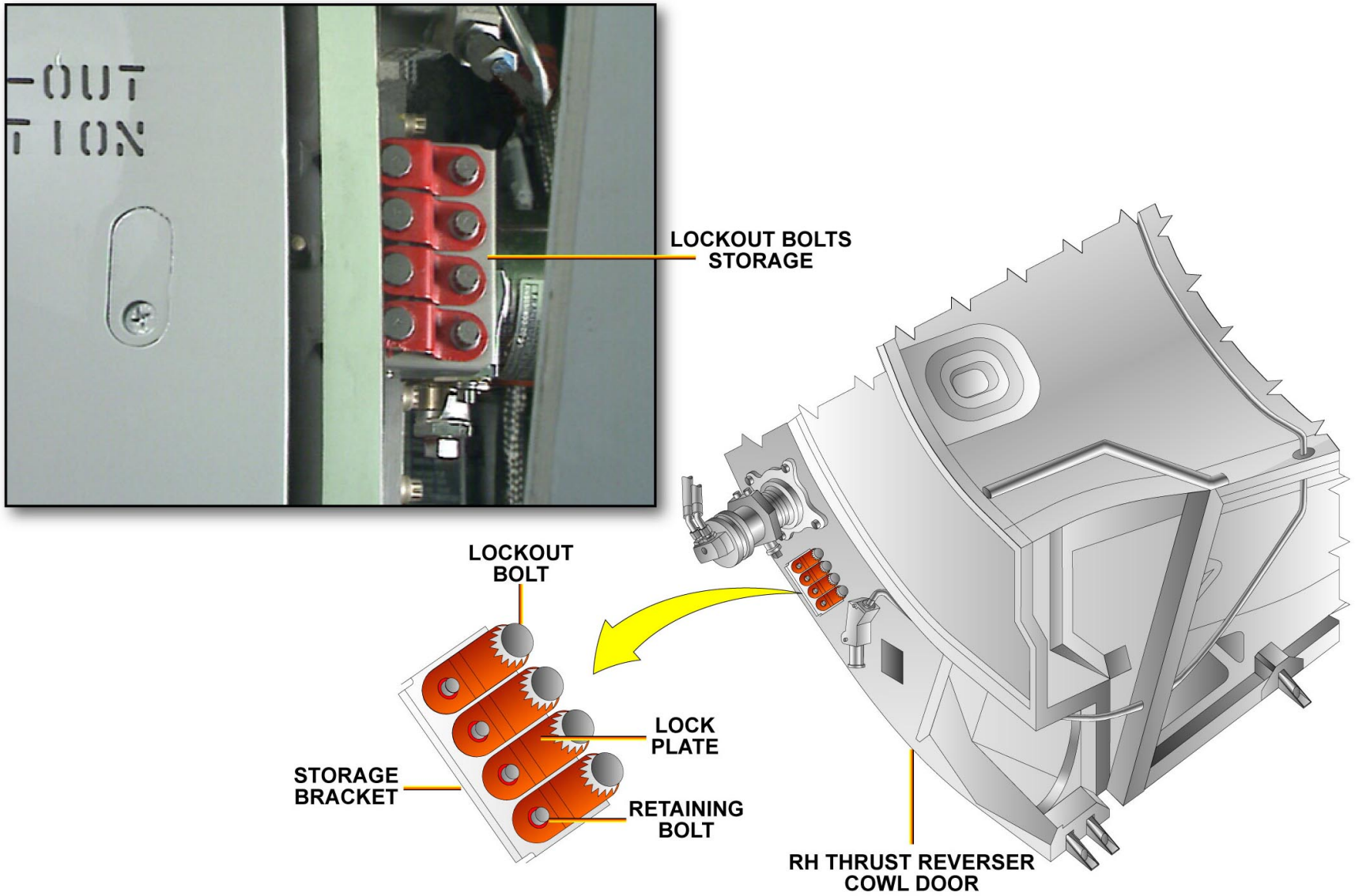
THRUST REVERSER DEACTIVATION LEVER

THRUST REVERSER DEACTIVATION & LOCKOUT (2)

THRUST REVERSER LOCKOUT BOLTS STORAGE

To lockout the pivoting doors, special lockout bolts and red lock plates are stored on a storage bracket located on the lower forward face of the right thrust reverser cowl door.

UG913131 - U7RT0EC - UM70Y3CFM000001



THRUST REVERSER LOCKOUT BOLTS STORAGE

THRUST REVERSER DEACTIVATION & LOCKOUT (2)

THRUST REVERSER LOCKOUT FAIRING

On each pivoting door a lockout fairing is removed to install lockout bolts in the lockout position.

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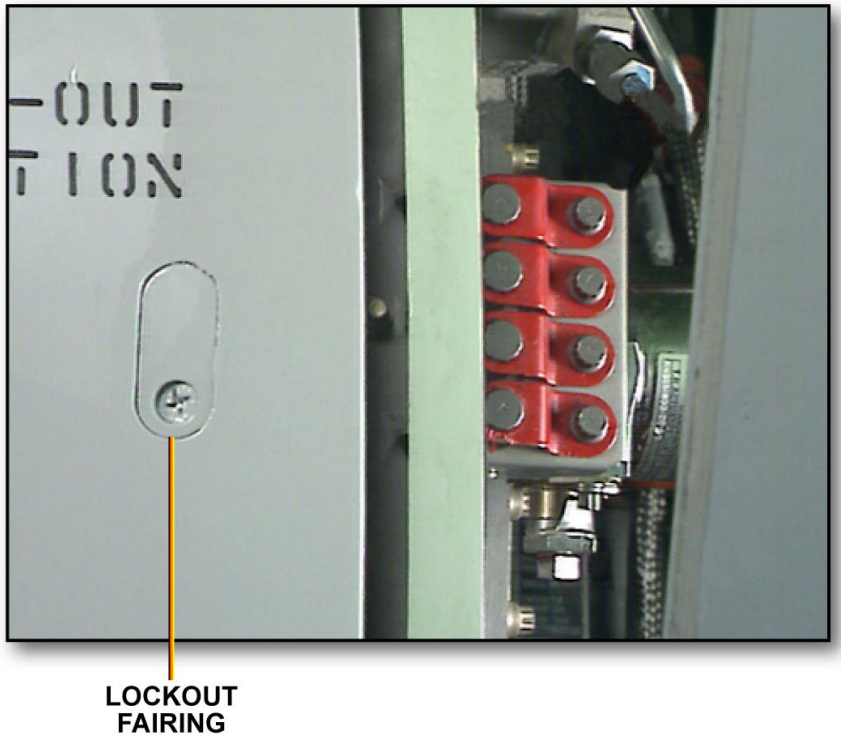
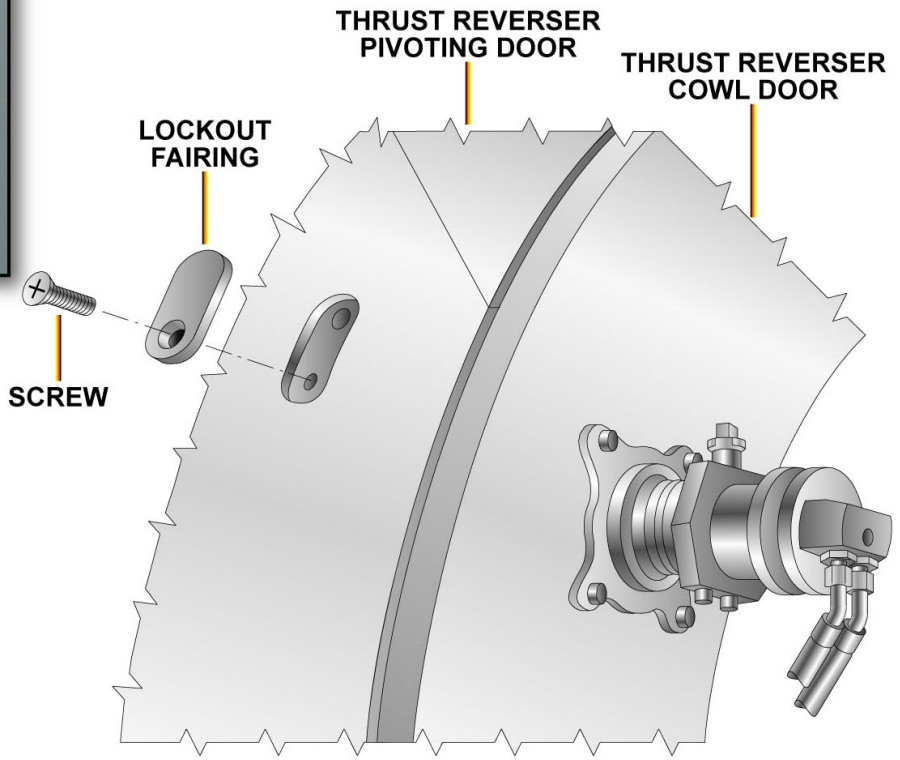




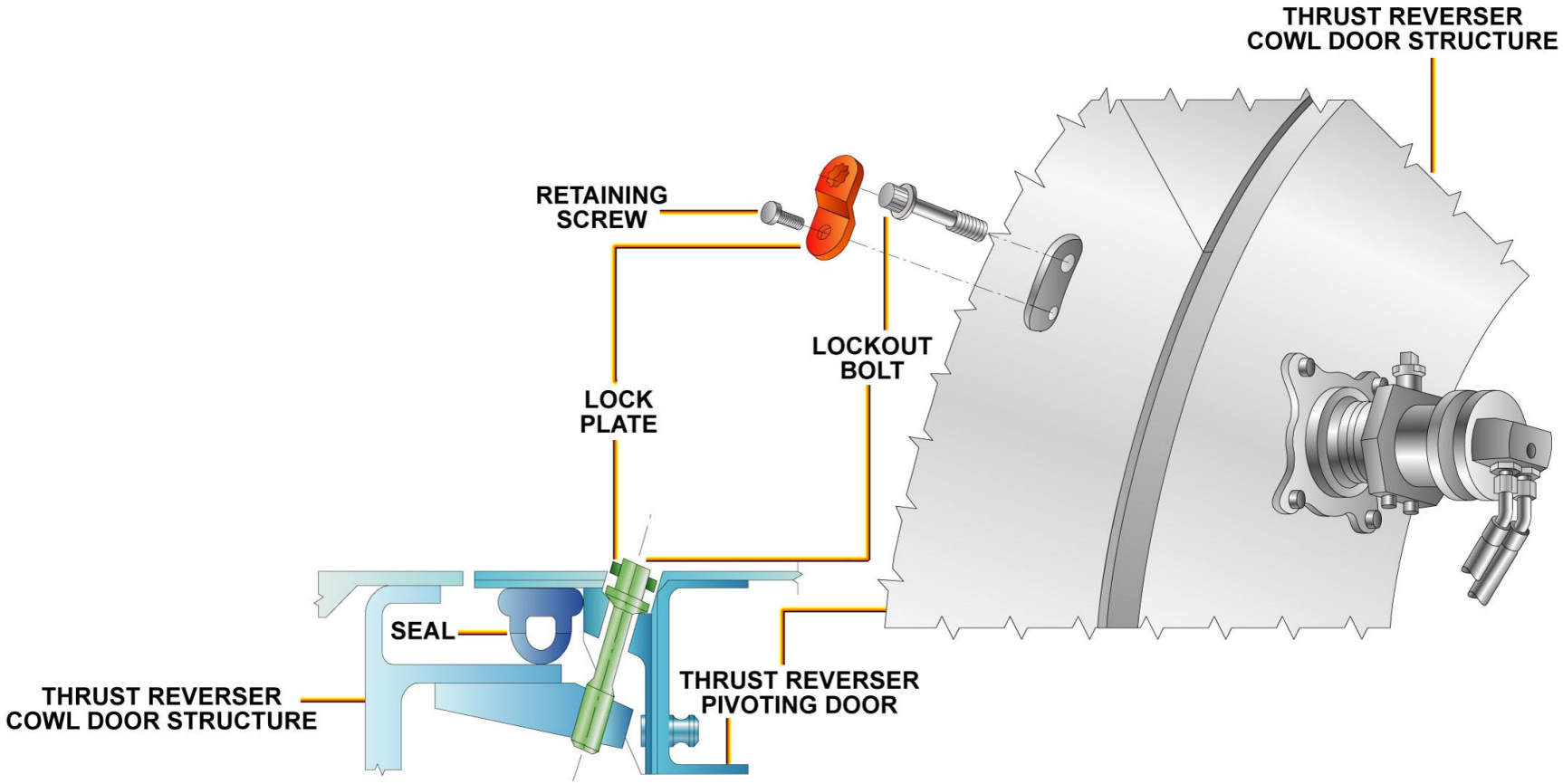
THRUST REVERSER LOCKOUT FAIRING

THRUST REVERSER DEACTIVATION & LOCKOUT (2)

THRUST REVERSER LOCKOUT BOLTS INSTALLATION

The lockout bolts are installed and secured by lock plates to attach the pivoting doors to the structure of the thrust reverser cowl doors.
The lockout fairing plates and screws are stored on the storage bracket instead of the lockout bolts and red lock plates.

UG913131 - U7RT0EC - UM70Y3CFM000001



THRUST REVERSER LOCKOUT BOLTS INSTALLATION

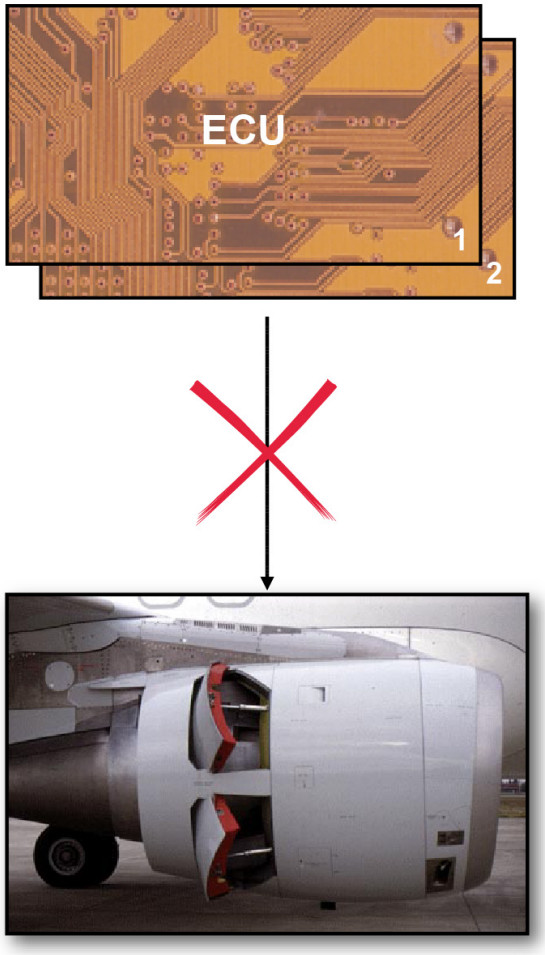
THRUST REVERSER DEACTIVATION & LOCKOUT (2)

THRUST REVERSER INHIBITION INDICATION

A caution "ENG X REV INHIBITED", activated through interactive mode, is displayed on the ECAM to advise the crew of the inoperative status of the thrust reverser, in case of mechanical inhibition for dispatch. In addition, when reversers are inhibited, the ECU will not command the thrust reverser deployment neither increases thrust at elevated REV IDLE LEVEL.

UG913131 - U7RT0EC - UM70Y3CFM000001

EWD



THRUST REVERSER INHIBITION INDICATION

POWER PLANT SYSTEM LINE MAINTENANCE (2)

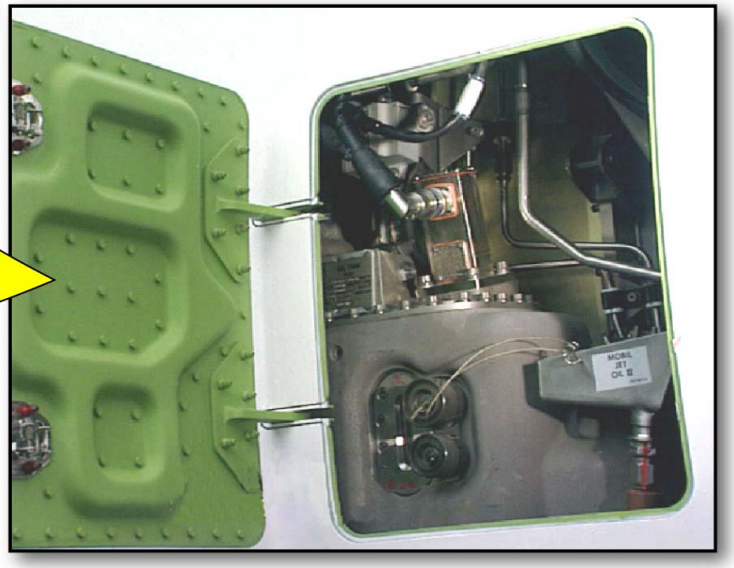
ENGINE OIL SERVICING

CAUTION: Caution: The engine should be shut down for at least 5 minutes prior to oil servicing. This allows the residual pressure in the oil tank to decrease. If you open the filler cap when there is pressure in the tank the hot oil can spray out and burn you.

- Open engine oil service door on left fan cowl,
- Check oil level on the sight gage on the oil tank,
- Raise filler cap handle to vertical (Unlocked position),
- Push down and turn the oil filler cap counterclockwise to remove,
- Add oil as necessary up to the FULL mark on the sight gage,
- Install oil filler cap - make sure to LOCK the cap.

NOTE: Note: It is also possible to Pressure Fill the engine oil. Two ports are installed on the oil tank, one for pressure and one for overflow. See AMM for procedure.

CFM56



OIL SERVICING ACCESS DOOR

ENGINE OIL SERVICING

POWER PLANT SYSTEM LINE MAINTENANCE (2)

IDG OIL LEVEL: VIEWER DOOR (OPTIONAL)

A viewing door is installed in the forward lower section of the right fan cowl door. The viewing door provides access to do a check of the IDG oil level without opening the fan cowl door. The door has quick release fasteners for easy access and a landyard to hold the door when it is open.

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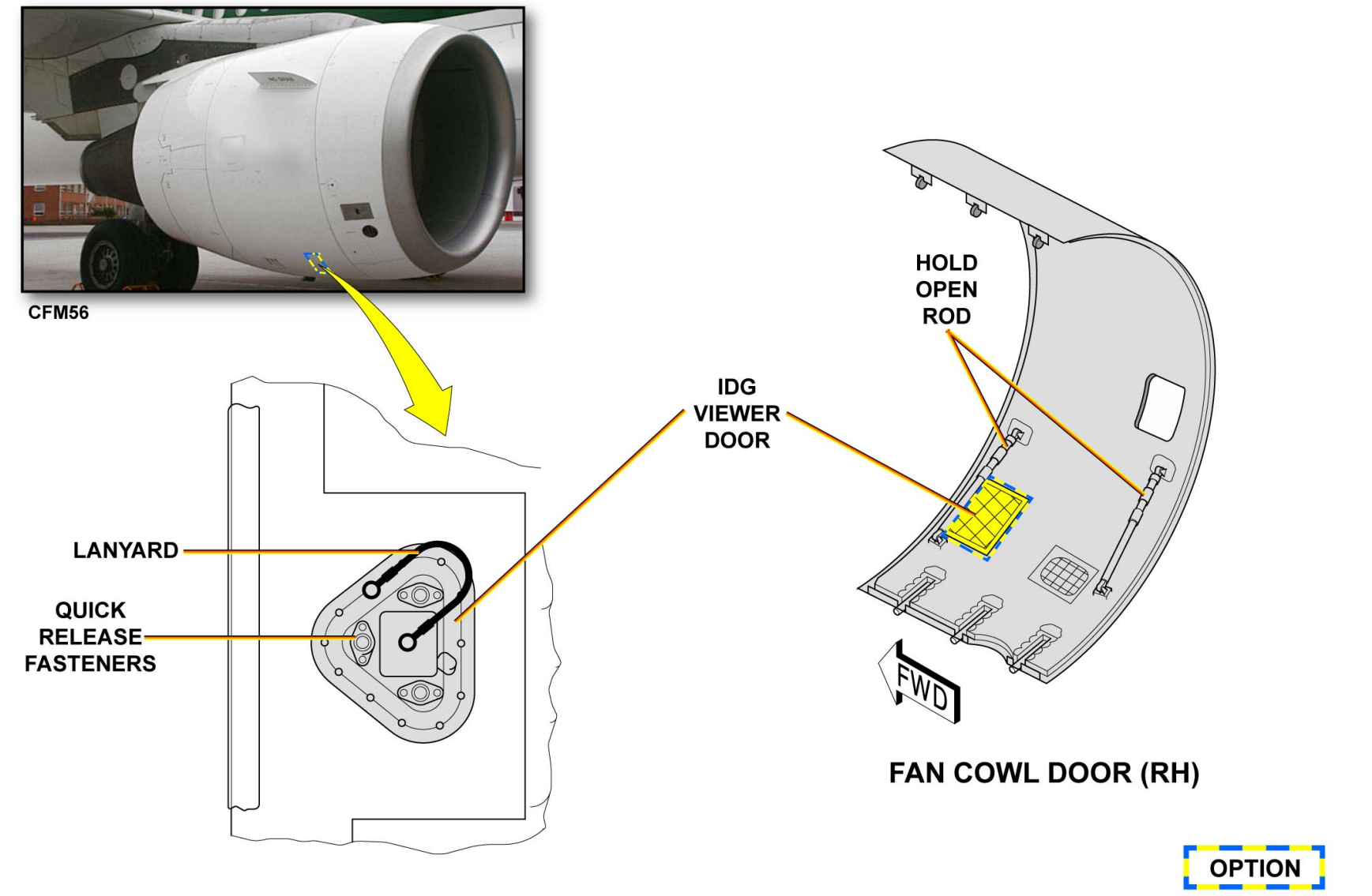


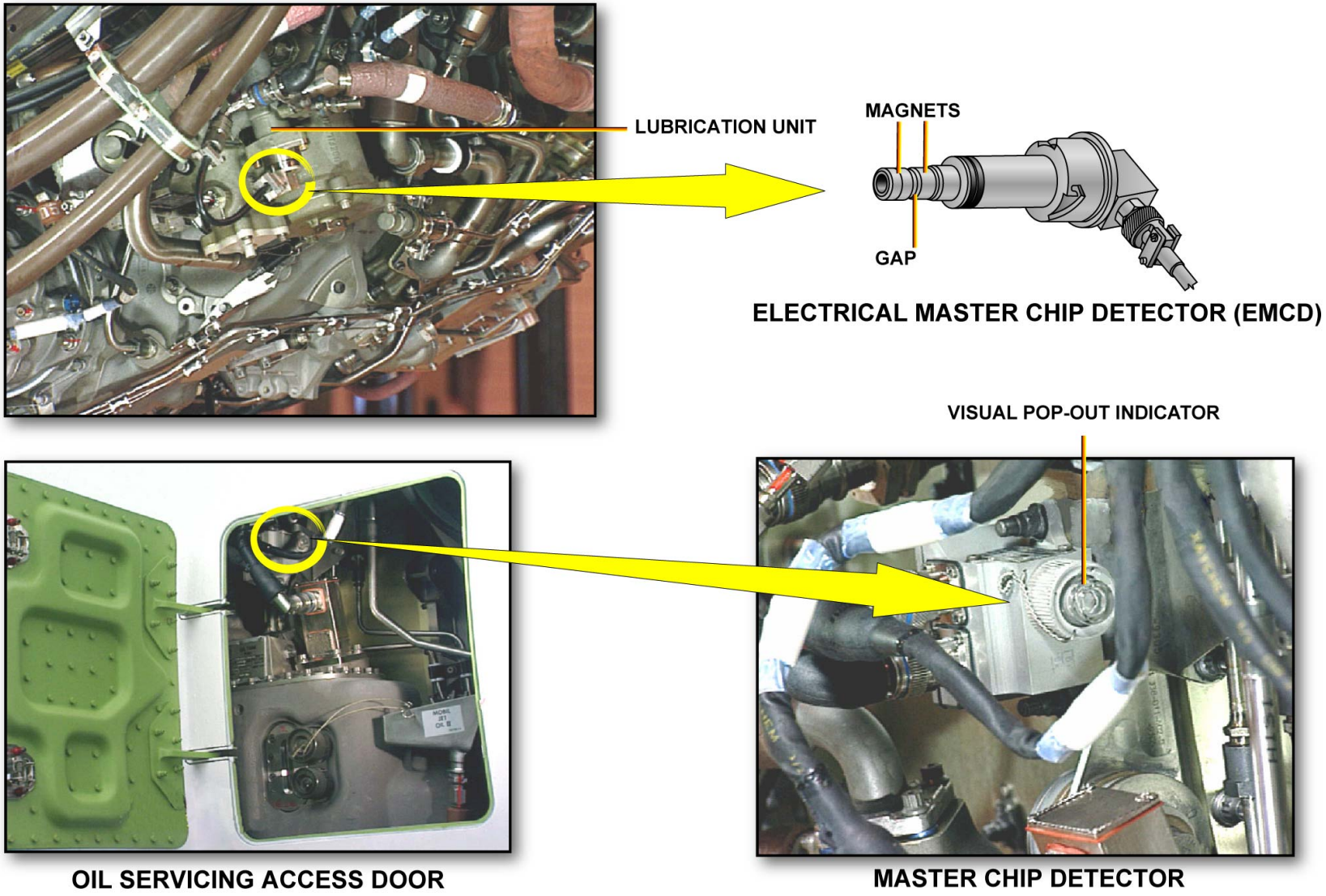
IDG OIL LEVEL: VIEWER DOOR (OPTIONAL)

POWER PLANT SYSTEM LINE MAINTENANCE (2)

MASTER CHIP DETECTOR CHECK

There is a red pop-out indicator visible from the oil-servicing door. If extended, this indicates that the Electrical Master Chip Detector (EMCD) is contaminated and the probe should be checked. To reset the red pop-out indicator, if necessary (depending on SB status of engine), remove the transparent cap and push in the clogging indicator with the thumb.
The EMCD probe is located on the lubrication unit and is made up of two magnets separated by a gap. The probe will collect any magnetic particles in the oil system. If the particle contamination closes the gap between the magnets an electrical signal is generated to extend the pop-out indicator. To check for contamination, remove the probe as follows:
- Open the left fan cowl,
- At the same time, push and turn the EMCD plug ¼ turn counterclockwise,
- Disengage the EMCD from its housing,
- Check the AMM for examples of NORMAL and ABNORMAL contamination,
- Clean the EMCD,
- Replace o-ring if necessary and re-install - check that the RED marks are aligned.

UG913131 - U7RT0EC - UM70BA00000001



MASTER CHIP DETECTOR CHECK

POWER PLANT SYSTEM LINE MAINTENANCE (2)

MEL/DEACTIVATION

FUEL FILTER CLOGGING

In case of a failure of the FUEL CLOG warning on ECAM, the aircraft may be dispatched per MEL as long as the fuel filter is changed once each day. The filter housing is part of the fuel pump assembly located on the accessory gearbox LH side. Procedure:
- FADEC GND PWR selected OFF,
- Open LH fan cowl,
- Drain residual fuel using drain plug,
- Open filter cover to remove and replace fuel filter element and o-rings,
- Re-install filter cover; check AMM for correct torque value for filter cover bolts,
- Perform minimum idle check for leaks,
- Close fan cowl.

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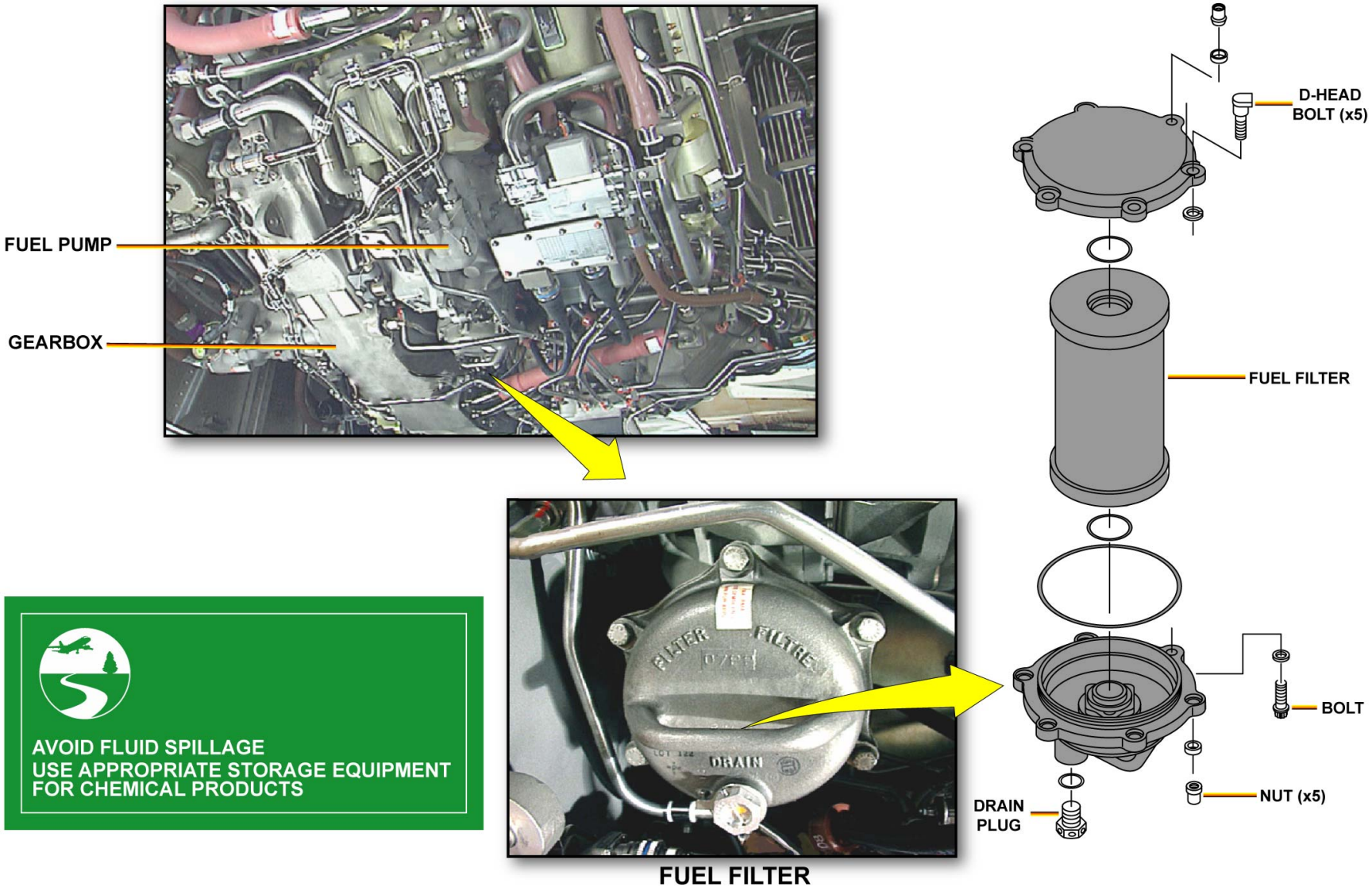

FUEL FILTER

MEL/DEACTIVATION - FUEL FILTER CLOGGING

POWER PLANT SYSTEM LINE MAINTENANCE (2)

MEL/DEACTIVATION (continued)

T/R DEACTIVATION AND LOCKOUT

Per the MEL, one or both Thrust Reversers may be deactivated in the STOWED position for dispatch. The deactivation procedure has two parts. First, the Hydraulic Control Unit (HCU) is deactivated. Moving the deactivation lever to the inhibit position prevents the pressurizing valve from supplying hydraulic pressure to the reverser actuators. In the second part of the deactivation procedure, each pivoting door is secured (bolted) to the reverser structure preventing any movement. To lockout the pivoting doors, special lockout bolts and red lock plates are stored on a storage bracket located on the lower forward face of the right thrust reverser cowl door. On each pivoting door a lockout fairing is removed to install lockout bolts in the lockout position. The lockout bolts are installed and secured by lock plates to attach the pivoting doors to the structure of the thrust reverser cowl doors. The lockout fairing plates and screws are stored on the storage bracket instead of the lockout bolts and red lock plates.

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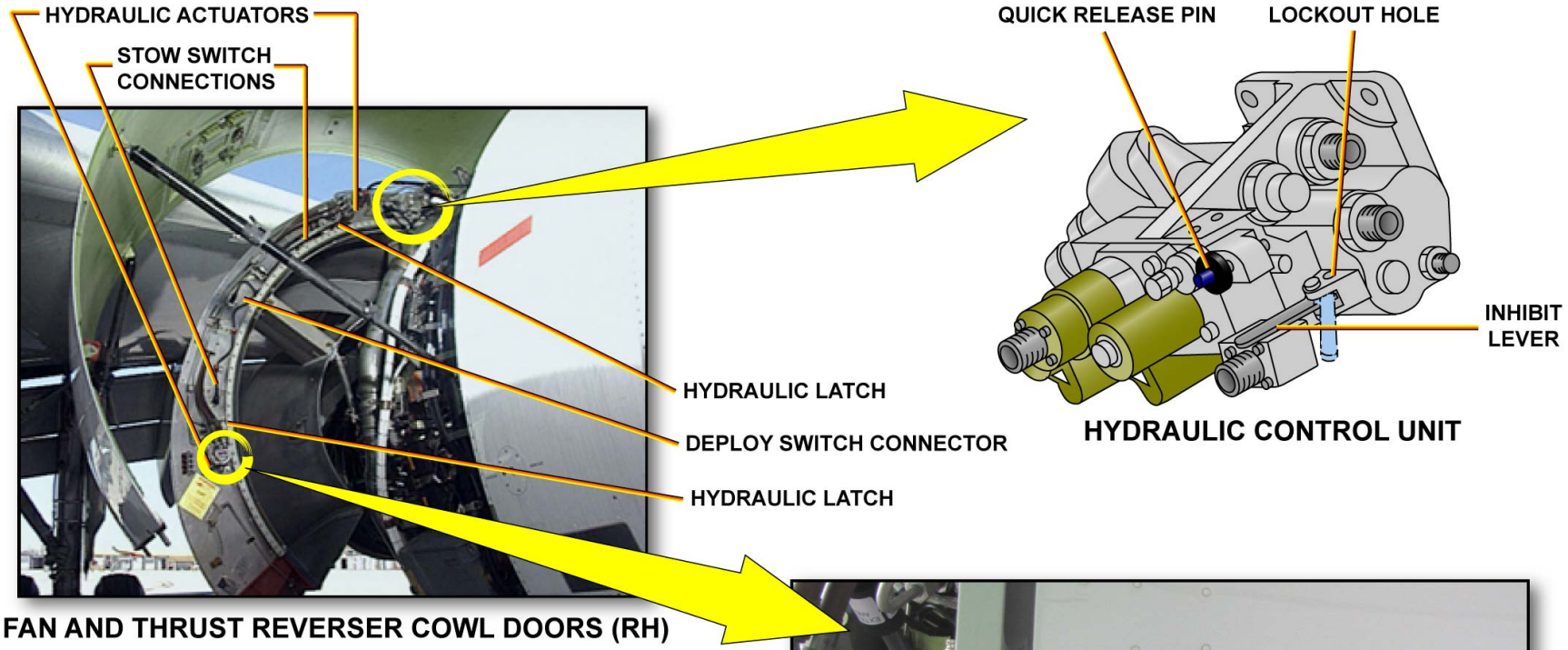
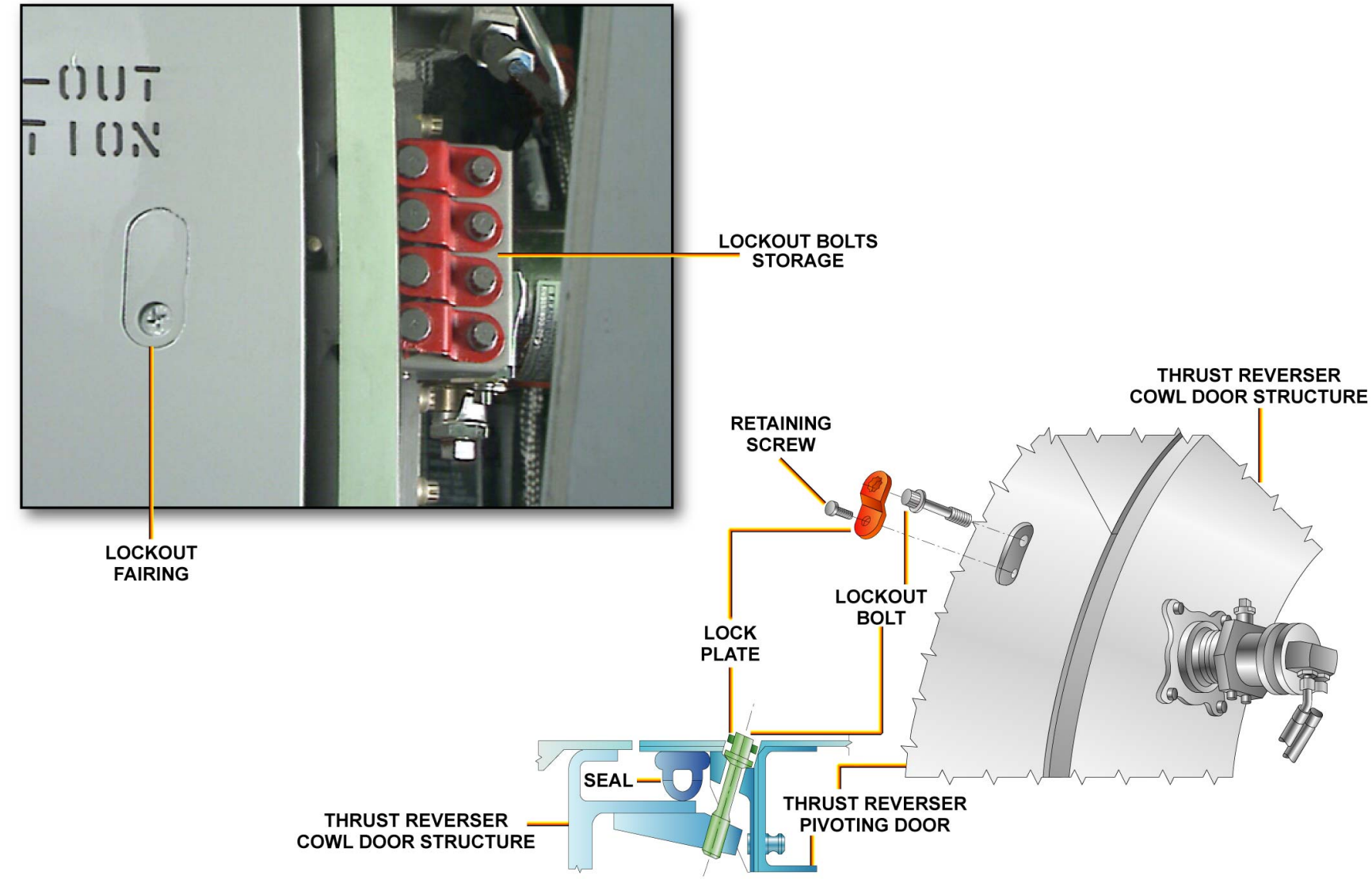


MEL/DEACTIVATION - T/R DEACTIVATION AND LOCKOUT



MEL/DEACTIVATION - T/R DEACTIVATION AND LOCKOUT

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POWER PLANT SYSTEM LINE MAINTENANCE (2)

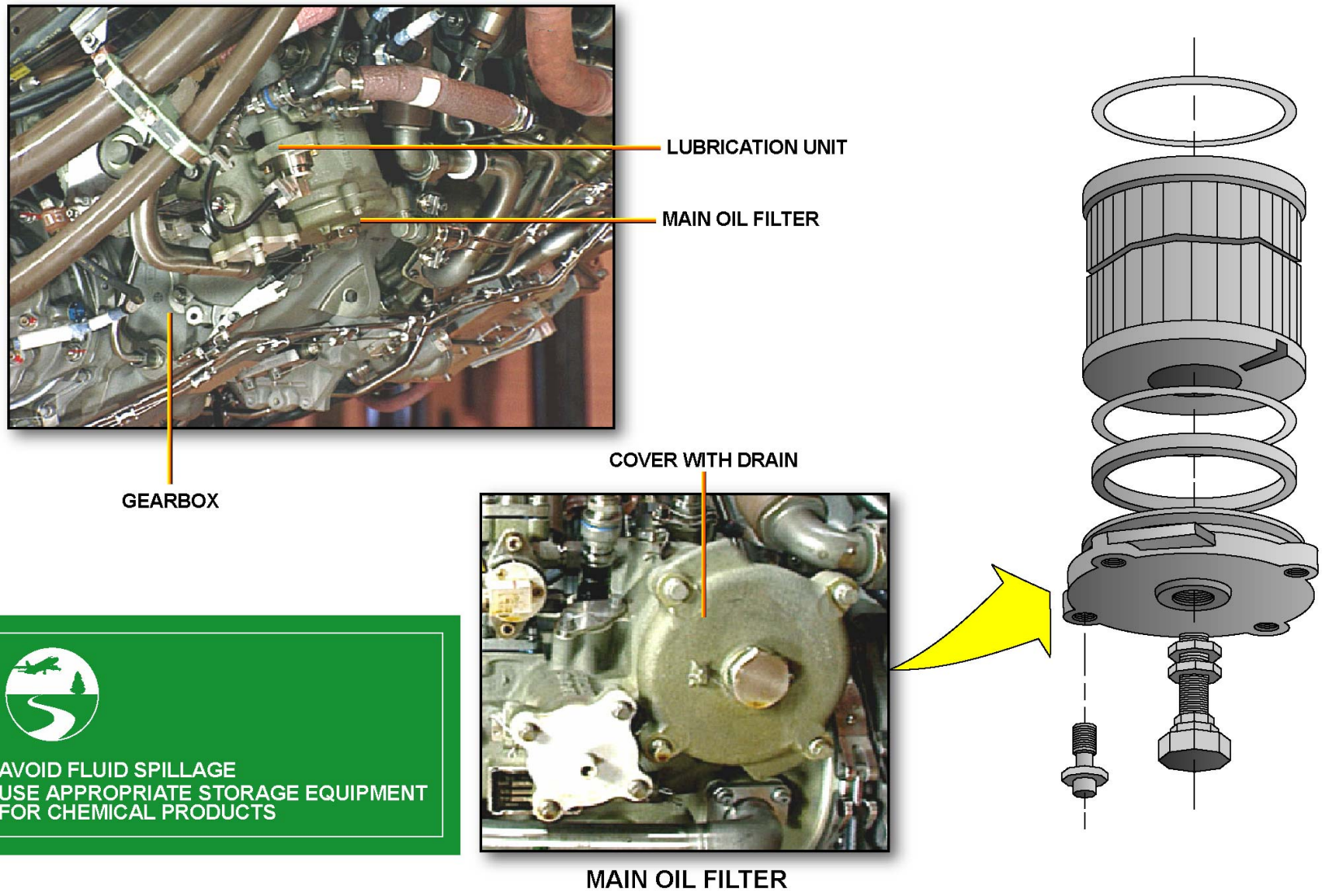
MEL/DEACTIVATION (continued)

OIL FILTER CLOGGING

In case of a failure of the OIL CLOG warning on ECAM, the aircraft may be dispatched per MEL as long as the scavenge filter is changed once each day. The filter housing lubrication unit located on the accessory gearbox LH side. Procedure:

- FADEC GND PWR selected OFF,
- Open LH fan cowl,
- Drain residual oil using drain plug,
- Open filter cover to remove and replace oil filter element and o-rings,
- Re-install filter cover, Check AMM/MEL for correct torque value for filter cover bolts,
- Check ECMD for contamination,
- Perform minimum idle check for leaks,
- Close fan cowl.

UG913131 - U7RT0EC - UM70BA00000001



MEL/DEACTIVATION - OIL FILTER CLOGGING

POWER PLANT SYSTEM LINE MAINTENANCE (2)

MEL/DEACTIVATION (continued)

START VALVE MANUAL OPERATION

In case of an electrical failure of the start valve, the valve may be operated manually to start the engine. The aircraft may be dispatched per the MEL with the valve INOP closed.

NOTE: Note: Do not operate the valve unless the starter system is pressurized. Damage to the valve can occur.

- Open the start valve access door on the RH cowl,
- Establish communications with the cockpit (Interphone jack on engine inlet cowl),
- On command from the cockpit, move start valve manual handle to the OPEN position,

NOTE: Note: Make sure you maintain pressure against the spring tension to keep the valve open.

- After engine start, on command from the cockpit, move start valve manual handle to CLOSED. Make sure that the start valve is fully closed.

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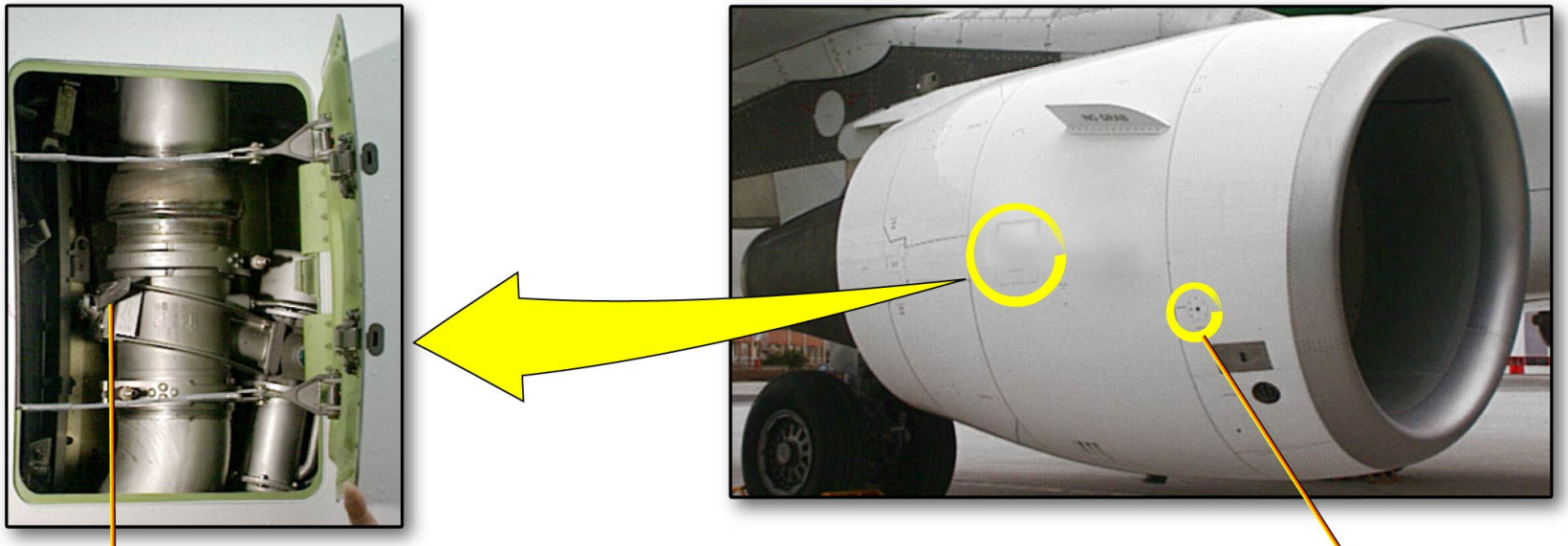


START VALVE MANUAL OPERATION — **FCOM Volume 3**

Advise ground crew to prepare for manual start operation.

- AUDIO CONTROL PANEL ..... CAB
  - When ground crew member is ready, order "START 1 or 2"
- ENG MODE SEL ..... IGN
- ENG MASTER ..... ON
- START VALVE....."ORDER OPEN AND KEEP OPEN"
  If not maintained in OPEN position by the ground crew member, the start valve closes.
  - When N2 at 50 %
- START VALVE....."ORDER CLOSE"
  Continue with normal procedure

MEL/DEACTIVATION - START VALVE MANUAL OPERATION

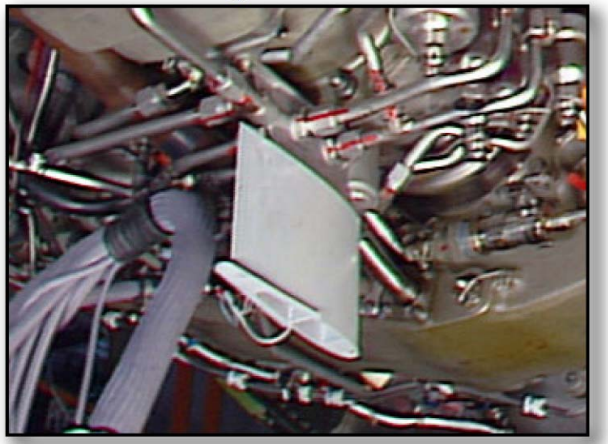
POWER PLANT SYSTEM LINE MAINTENANCE (2)

MAINTENANCE TIPS

The engine and pylon drain system is designed to collect fuel, oil, water and hydraulic fluid from engine systems and accessories and discharge them overboard through the engine drain mast and the pylon drain tubes. For troubleshooting and leak isolation a drain collector is installed on the accessory gearbox. The drain collector supplies the drain manifold module, which supports the drain mast. The drain mast also has separate drains for additional leak isolation. The pylon drain tubes collect fluids from individual pylon chambers, also for leak isolation.
If fluid leaks are found during transit operations, the AMM (ATA 70-00 & ATA 29-00) lists maximum permitted leakage limits for the drain system. There are limits for STATIC (engine not running) and DYNAMIC (engine running) conditions. Here are some examples of leakage limits for dispatch. See the AMM for complete list.

NOTE: In the case of extreme cold weather condition (Outside Air Temperature (OAT) <- 20 deg.C (- 4 deg.F), fuel leaks from the drain mast may occur on a non-running engine and during engine start. This leakage is
expected to stop after a 5 minute warm-up at minimum idle.

PYLON DRAIN


ENGINE DRAIN

Examples of leakage limits for dispatch.
See the AMM for complete list.

STATIC FUEL leaks (ATA 70)
< 60 drops/minute: - No maintenance action required
> 60 drops/minute: - Start engine and run at idle for 5 minutes and refer to DYNAMIC limits

DYNAMIC FUEL leaks (ATA 70)
< 60 drops/minute: - No maintenance action required
> 60 but < 90 drops/minute: - corrective action within 25 cycles
> 90 drops/minute: - leakage test required

OIL leaks (ATA 70)
< 7 drops/minute: - No maintenance action required
> 7 drops/minute: - leakage test required

HYDRAULIC leaks (ATA 29)
STATIC Engine driven pump seal > 8 drops/minute:
- repair or replace the component as necessary

DYNAMIC Engine driven pump seal > 60 drops/minute:
- repair or replace the component as necessary

Pipe-to-pipe connections > 2 drops in 10 minutes:
- repair or replace the component as necessary

MAINTENANCE TIPS

POWER PLANT SYSTEM LINE MAINTENANCE (2)

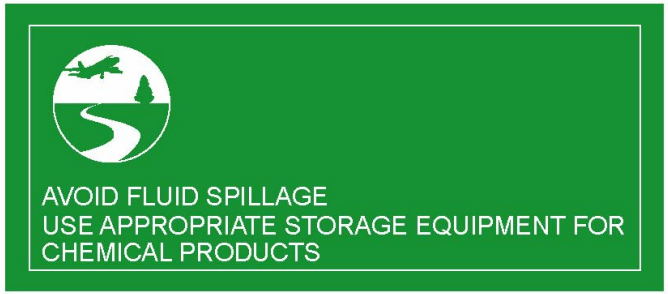
ENVIRONMENTAL PRECAUTIONS

Do not discharge products such as oil, fuel, solvent, lubricant either in trash bins, soil or into the water network (drains, gutters, rain water, waste water, etc...).
Sort waste fluids and use specific waste disposal containers.
Each product must be stored in an appropriate and specific cabinet or room such as a fire-resistant and sealed cupboard.

UG913131 - U7RT0EC - UM70BA00000001

STORE PRODUCTS IN APPROPRIATE CONTAINER/CUPBOARD/ROOM

SORT WASTE FLUIDS IN CONTAINERS



FLUID SPILL CLEANUP KIT

USE SPECIFIC WASTE DISPOSAL CONTAINERS

ENVIRONMENTAL PRECAUTIONS

MANUAL OPERATION OF T/R PIVOTING DOOR (3)

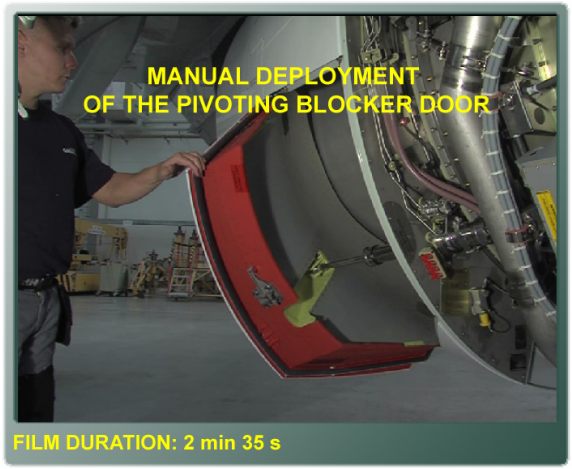
MANUAL DEPLOYMENT OF THE PIVOTING BLOCKER DOOR

Before working on the engine safety precautions have to be taken in the cockpit. On panel 115VU put a warning notice to tell people not to start the engines. On the overhead panel, panel 50VU make sure that the ON legend from the FADEC ground power switch is off and install a warning notice.
Open the Fan Cowl Doors and deactivate the Thrust Reverser System.
To enable the manual unlocking of the hydraulic latch a part of the thermal blankets has to be removed.
Turn the Dzus (pronounced Zooss) fastener on the thermal blanket to loosen it and remove the blanket from the related blocker door latch.
Turn the manual unlock shaft on the blocker door latch to the unlock position, using a 5/16 in spanner.
The manual unlock shaft can be accessed through a slot on the blocker door latch.
Pull on the door to make sure that it can not be opened yet. The lock inside of the actuator prevents the opening of the door. If the door opens replace the actuator.
To unlock the hydraulic actuator turn the manual unlock square on the actuator to the unlock position, using a spanner.
Now the hydraulic latch and actuator are released and the pivoting blocker door opens.
Open the blocker door by manually pulling on the edge.

CAUTION: To prevent damage, do not push on the stow switch lever when the blocker door is open.

For safety reasons install a safety sleeve on the hydraulic actuator rod of the deployed door.
Once the door is open and secured maintenance tasks are allowed.
This completes the manual opening procedure.

UG913131 - U7RT0EC - UM70Y4CFM000001



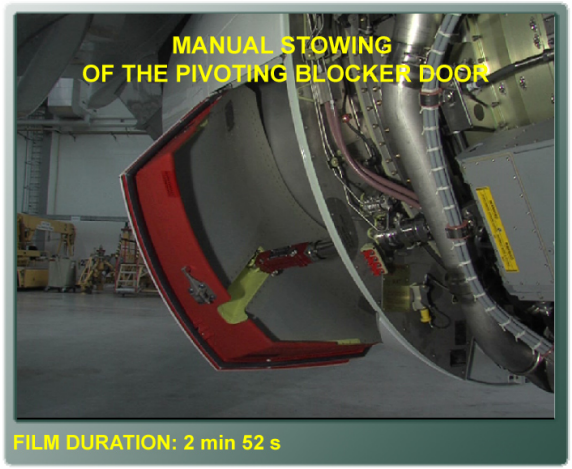
MANUAL DEPLOYMENT OF THE PIVOTING BLOCKER DOOR

MANUAL OPERATION OF T/R PIVOTING DOOR (3)

MANUAL STOWING OF THE PIVOTING BLOCKER DOOR

Before closing the blocker door obey all safety precautions in accordance to the Aircraft Maintenance Manual and make sure that the Thrust Reverser System is deactivated at the Hydraulic Control Unit.
Remove the safety sleeve from the blocker door actuator.
Now push in on the blocker door until you hear the latch engaging and make sure that the blocker door is flush with the Thrust Reverser Cowl Structure.
Maintenance Tip: Use one of the pivoting blocker door lock out bolts, if you are not able to push the door completely into the closed and locked position with your hands.
Remove the lock out fairing from the pivoting blocker door.
Insert the lock out bolt and tightened it until you hear the blocker door latch lock. Make sure that the blocker door is flush with the Thrust Reverser Cowl Structure and remove the lock out bolt.
After removal of lock out bolt, re-install the lock out fairing and torque it in accordance to the values given in the AMM. Re-install the lock out bolt into the bracket position and torque it in accordance to the AMM.
Put the thermal blanket on the blocker door latch. Turn the Dzus fastener on the blanket ¼ turn to lock it.
Make the Thrust Reverser serviceable in accordance to the AMM. Make sure that the work area is clear of tools and other items. Close the Fan Cowl doors and remove the warning notices in the cockpit.
This completes the manual stowing procedure of the pivoting blocker door.

UG913131 - U7RT0EC - UM70Y4CFM000001



MANUAL STOWING OF THE PIVOTING BLOCKER DOOR

MANUAL OPERATION OF T/R PIVOTING DOOR (3)

THRUST REVERSER DEACTIVATION LEVER

For safety reasons the thrust reverser system must be deactivated using the HCU de-activation lever before manual operation.
Use a safety pin with a streamer to indicate the reverser as unserviceable.

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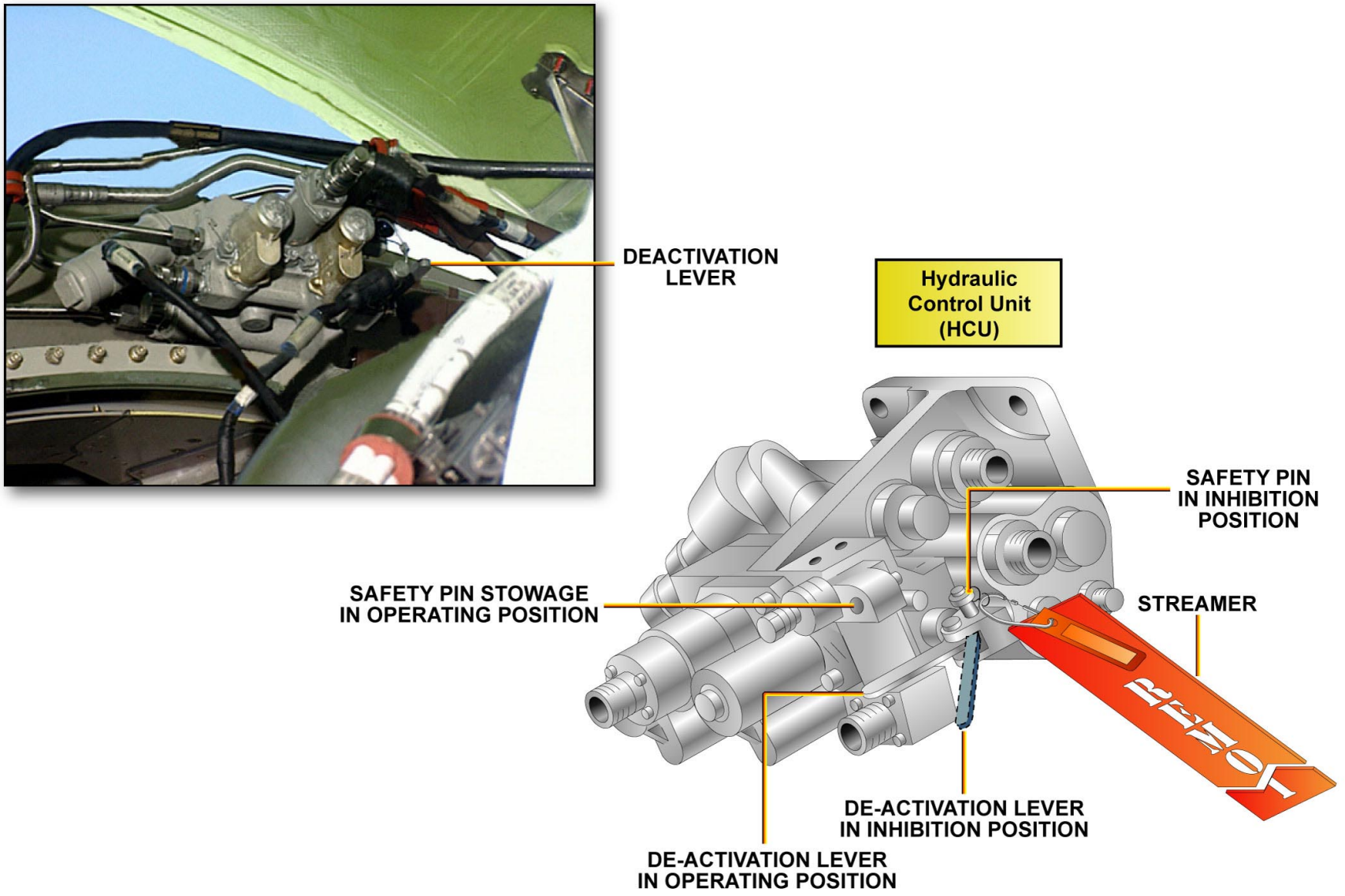
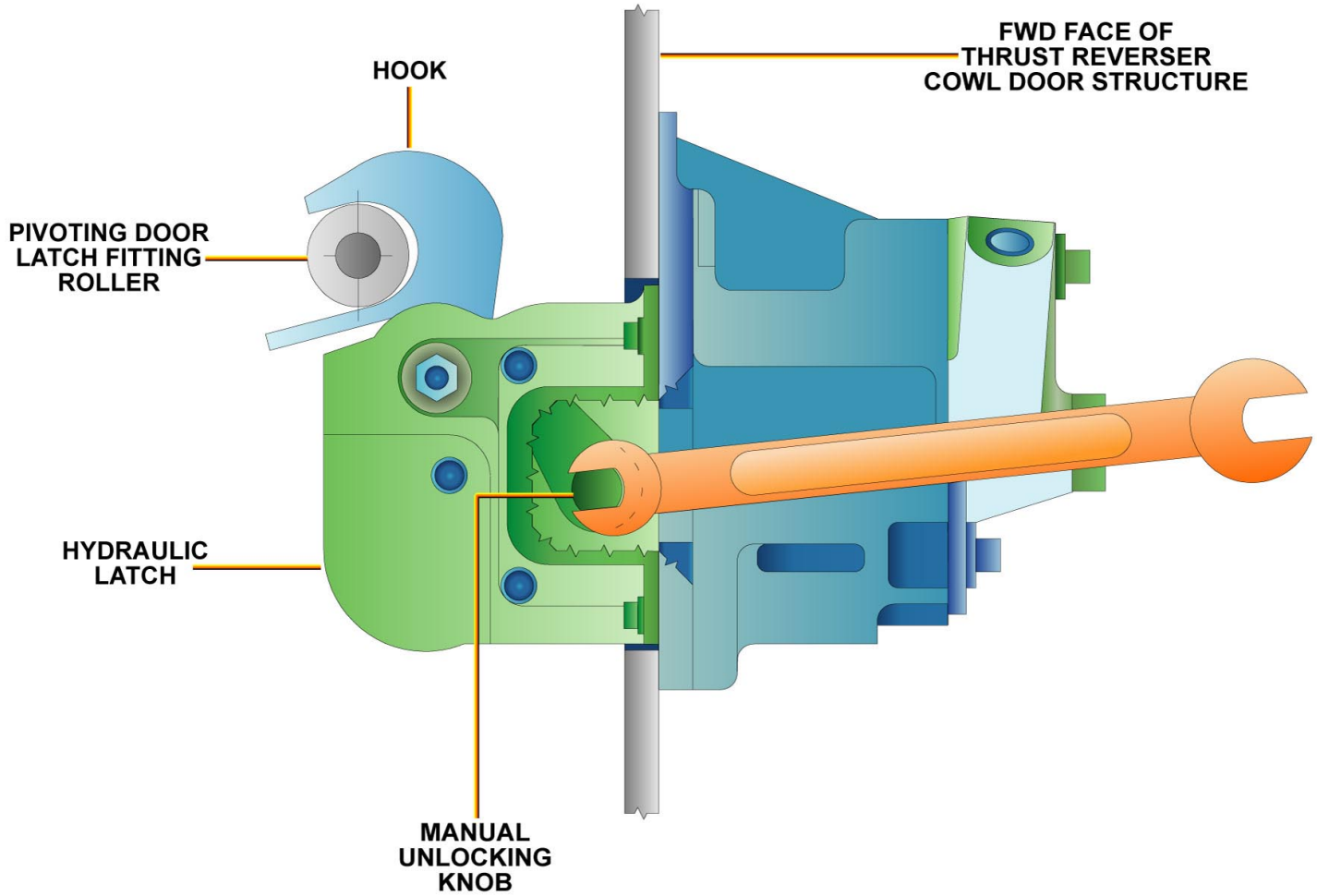

DEACTIVATION LEVER
Hydraulic Control Unit (HCU)
SAFETY PIN IN INHIBITION POSITION
SAFETY PIN STOWAGE IN OPERATING POSITION
STREAMER
DE-ACTIVATION LEVER IN INHIBITION POSITION
DE-ACTIVATION LEVER IN OPERATING POSITION

THRUST REVERSER DEACTIVATION LEVER

MANUAL OPERATION OF T/R PIVOTING DOOR (3)

HYDRAULIC LATCH MANUAL UNLOCKING

On each hydraulic latch, a manual unlocking knob is provided to manually release the hook from its pivoting door.
Use a conventional open-ended 5/16 inch wrench.



HYDRAULIC LATCH MANUAL UNLOCKING

MANUAL OPERATION OF T/R PIVOTING DOOR (3)

HYDRAULIC ACTUATOR MANUAL UNLOCKING SQUARE

To open a pivoting door, a manual unlocking square is fitted on each hydraulic actuator to release the actuator claw device.
Use a conventional open-ended 3/8 inch wrench.

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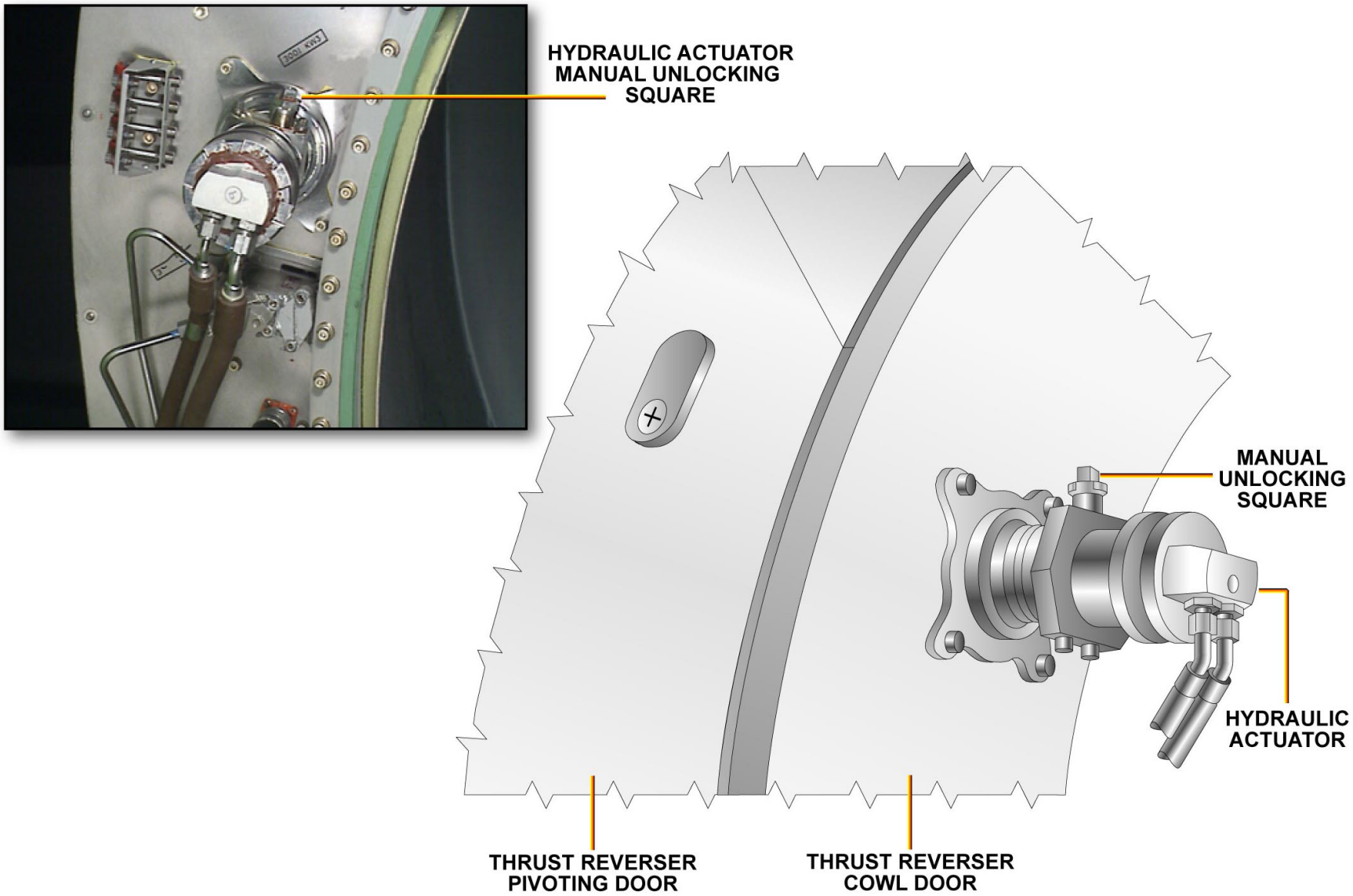

HYDRAULIC ACTUATOR MANUAL UNLOCKING SQUARE

MANUAL OPERATION OF T/R PIVOTING DOOR (3)

SAFETY SLEEVE INSTALLATION

When the pivoting door is open, a safety sleeve must be installed to secure it in the open position.
During the manual closing sequence, the latch and actuator are mechanically locked.

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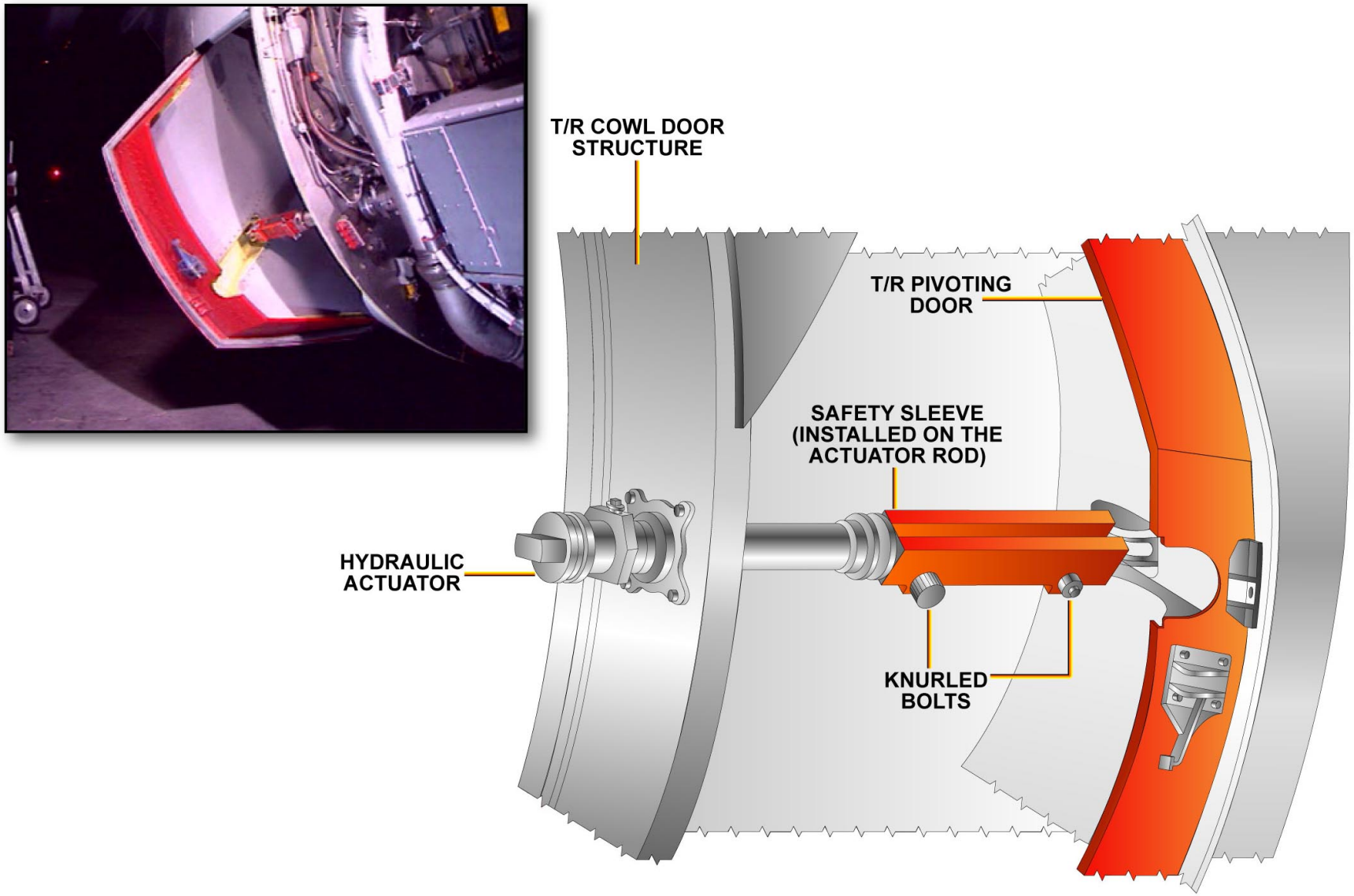

SAFETY SLEEVE INSTALLATION

ENGINE REMOVAL AND INSTALLATION OVERVIEW (3)

PRECAUTIONS

Make sure that you have the correct fire fighting equipment available before you start any task on the fuel system.
Make sure that the landing gear safety-locks and the wheel chocks are in position.
Put the safety devices and the warning notices in position before you start any task on or near:
- the flight controls,
- the flight control surfaces,
- the landing gear and the associated doors,
- or any component that moves.

Make sure that all the circuits in maintenance are isolated before you supply electrical power to the aircraft.
Make sure that the ENG MASTER control switch is OFF, slats are retracted and the appropriate circuit breakers are open.
Note that before removing the engine, the electrical, fuel, hydraulic and pneumatic connections must be disconnected from the pylon interface panel and ducts.

UG913131 - U7RT0EC - UM70Y5CFM000001

WARNING

- CORRECT FIRE FIGHTING EQUIPMENT.
- LANDING GEAR SAFETY-LOCKS AND WHEEL CHOCKS IN POSITION.
- SAFETY DEVICES AND WARNING NOTICES IN POSITION.
- ALL CIRCUITS ISOLATED.
- ENGINE MASTER LEVER SET TO OFF, SLATS RETRACTED AND APPROPRIATE CIRCUIT BREAKERS OPEN.

(115VU)

PRECAUTIONS

ENGINE REMOVAL AND INSTALLATION OVERVIEW (3)

ENGINE INTERFACES

Engine interfaces on the engine LH side are:
- fluid disconnect panel: fuel, hydraulics,
- thrust reverser electrical junction box: on the LH thrust reverser cowl door,
- pneumatic system coupling: in engine FWD mount zone.

Engine interfaces on the engine RH side are:
- core electrical junction box,
- fan electrical connector panel: including Integrated Drive Generator (IDG) harness connector,
- thrust reverser Hydraulic Control Unit (HCU) harness connectors: on the RH thrust reverser cowl door,
- starter duct coupling.

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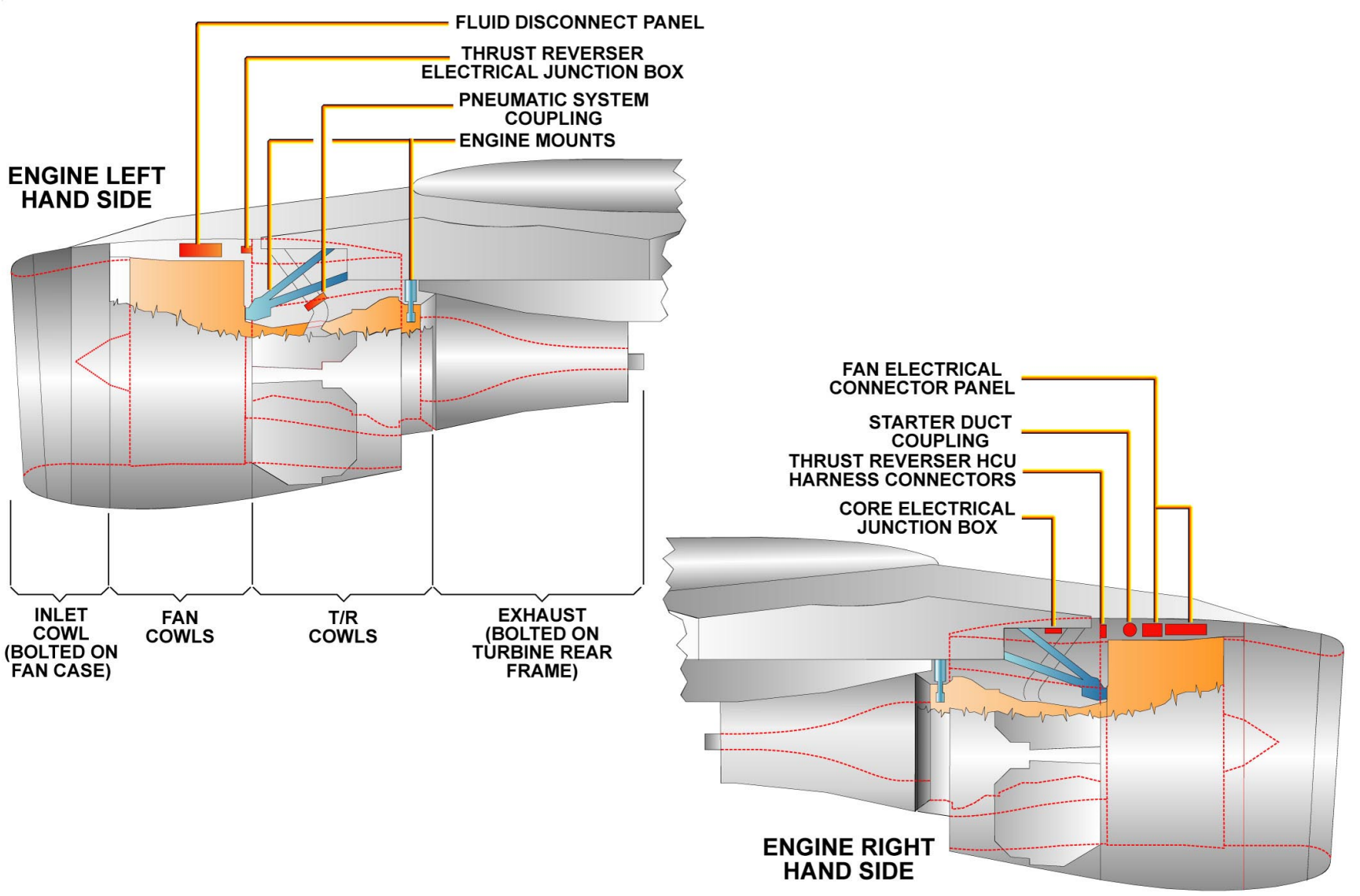

ENGINE INTERFACES

ENGINE REMOVAL AND INSTALLATION OVERVIEW (3)

HOLD OPEN COWL BRACE INSTALLATION

To support the fan and thrust reverser cowls, during engine removal or installation, special braces are installed.
This enables the engine to be changed under the wing without removing the fan cowls and the thrust reverser cowl doors.

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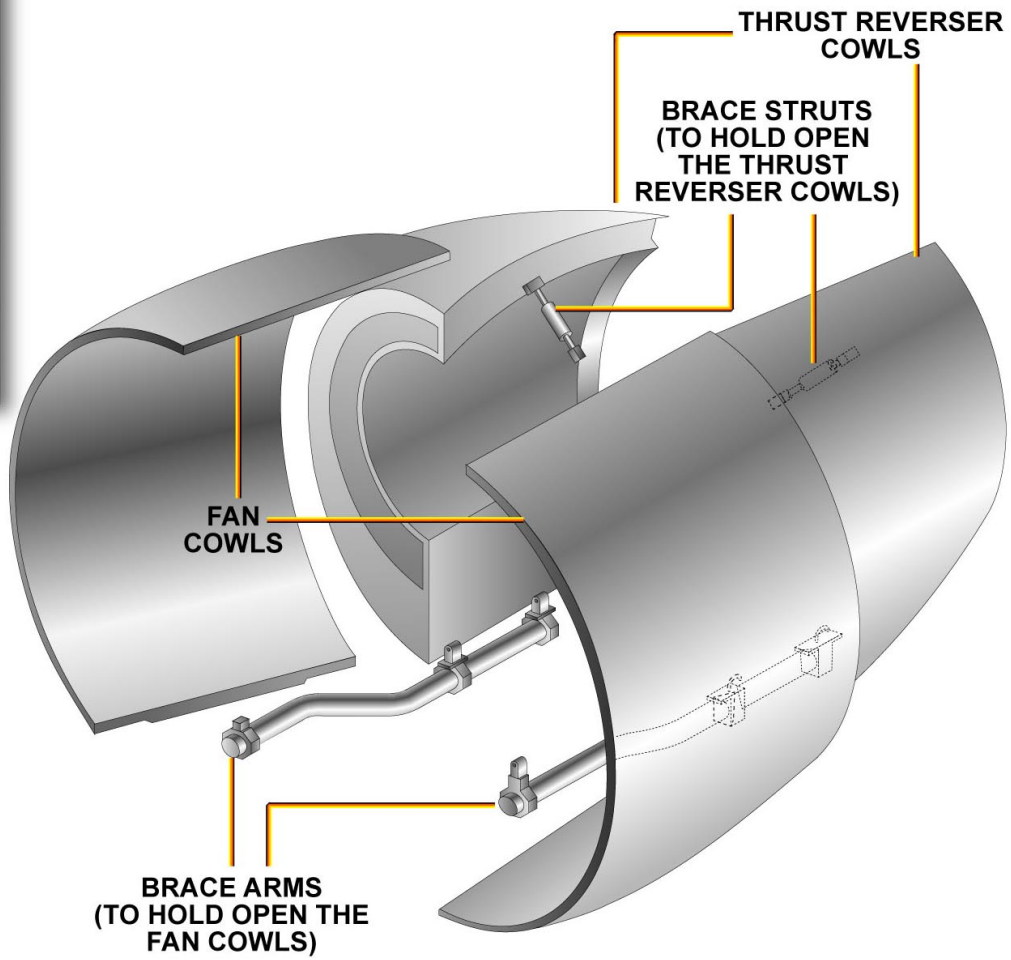
THRUST REVERSER COWLS
BRACE STRUTS (TO HOLD OPEN THE THRUST REVERSER COWLS)
FAN COWLS
BRACE ARMS (TO HOLD OPEN THE FAN COWLS)

HOLD OPEN COWL BRACE INSTALLATION

ENGINE REMOVAL AND INSTALLATION OVERVIEW (3)

ENGINE REMOVAL AND INSTALLATION SYSTEMS

Equipment used for engine removal or installation is:
bootstraps installed on the forward mount and rear part of the pylon.
Four dynamometers and chain pulley blocks are installed at the end of the bootstraps to ensure the correct tension during engine removal or installation.

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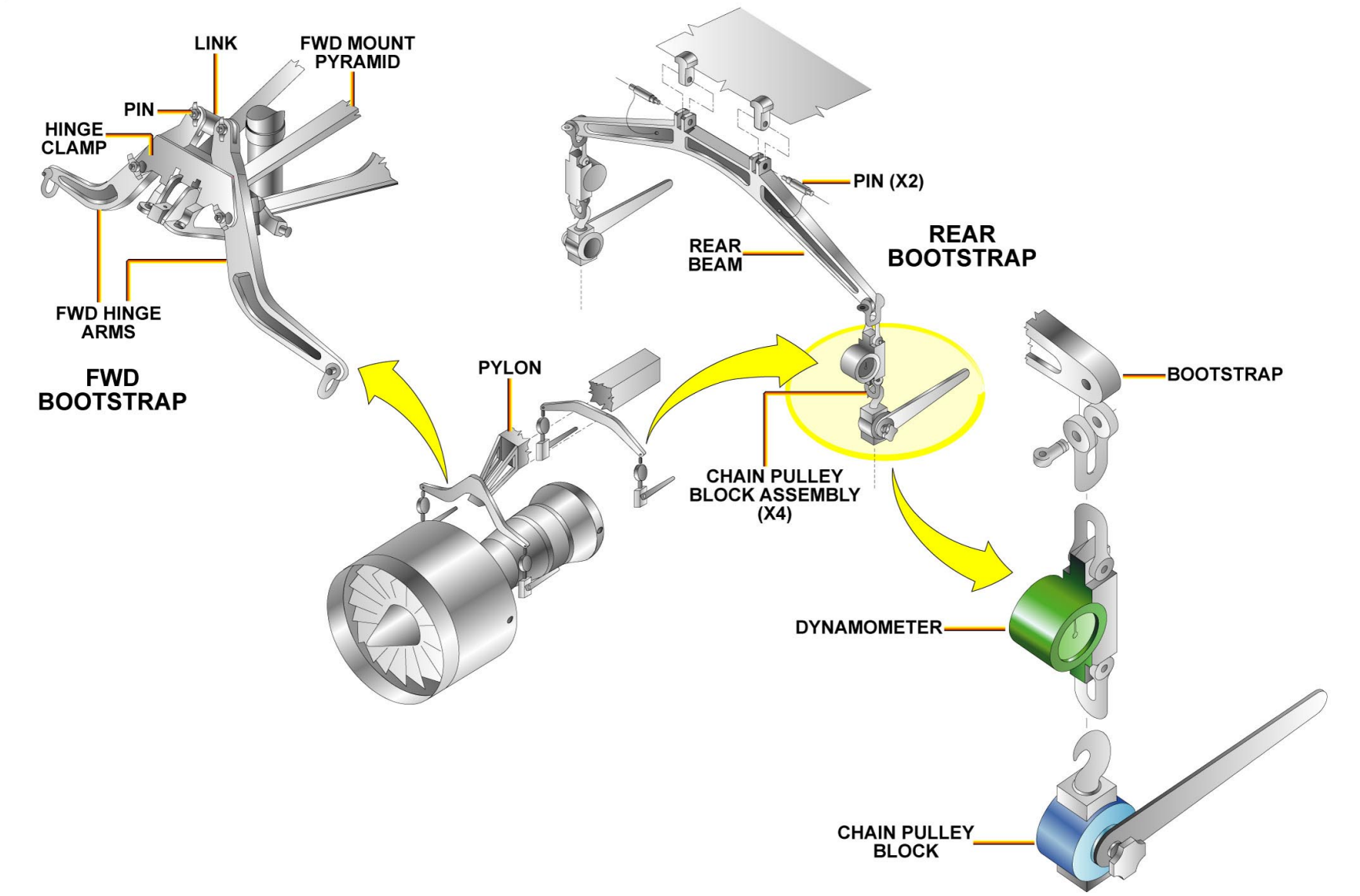

ENGINE REMOVAL AND INSTALLATION SYSTEMS

ENGINE REMOVAL AND INSTALLATION OVERVIEW (3)

ENGINE CRADLE AND TROLLEY

The engine cradle and trolley are two associated tools, which let the engine to be removed and carried.

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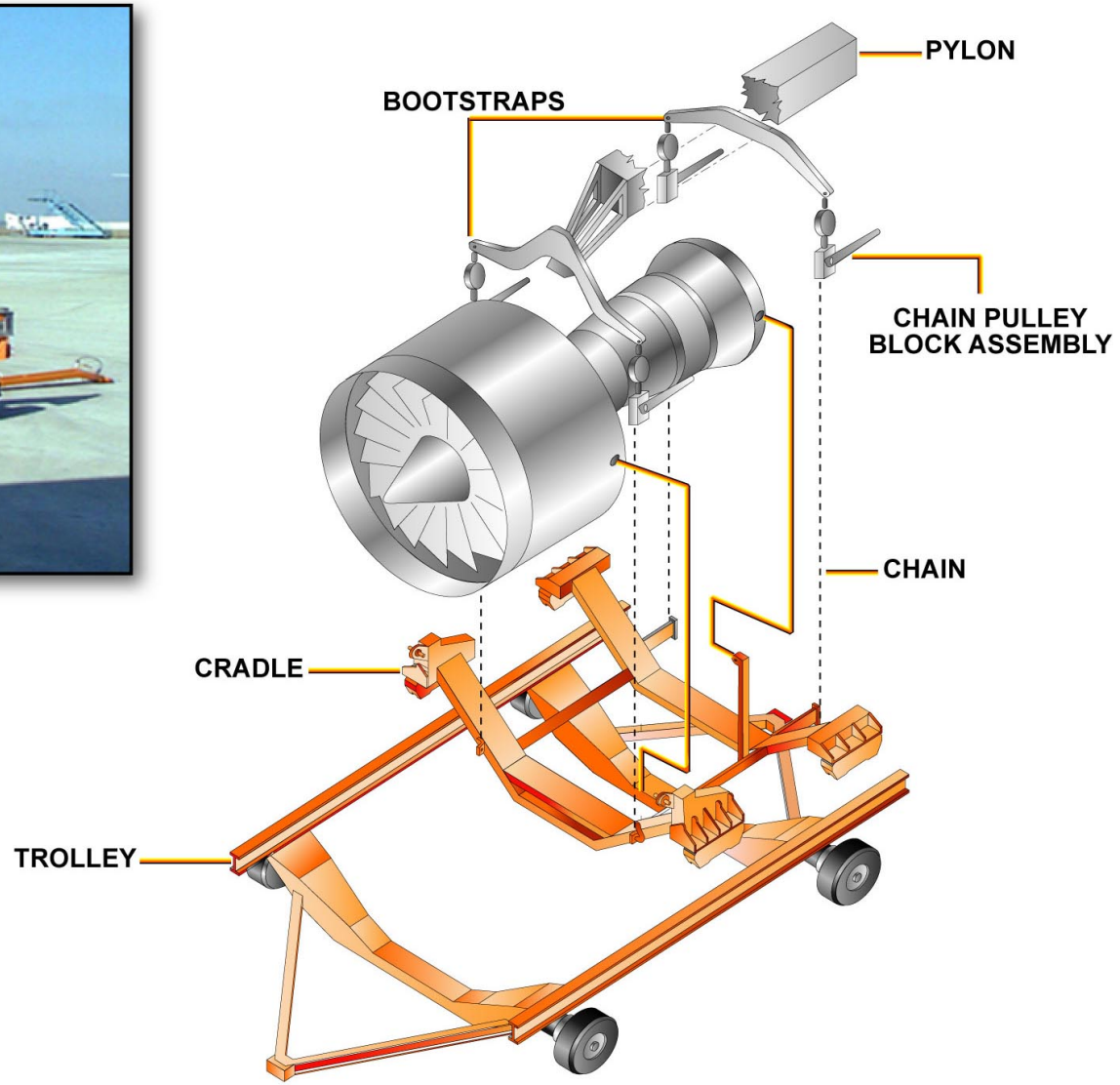

ENGINE CRADLE AND TROLLEY

ENGINE REMOVAL AND INSTALLATION OVERVIEW (3)

ENGINE HYDRAULIC POSITIONER

The engine hydraulic positioner is a special hydraulic trolley, which supplies easy positioning and engine installation.
For engine transportation, the same cradle can be transferred from the engine hydraulic positioner to a standard trolley.

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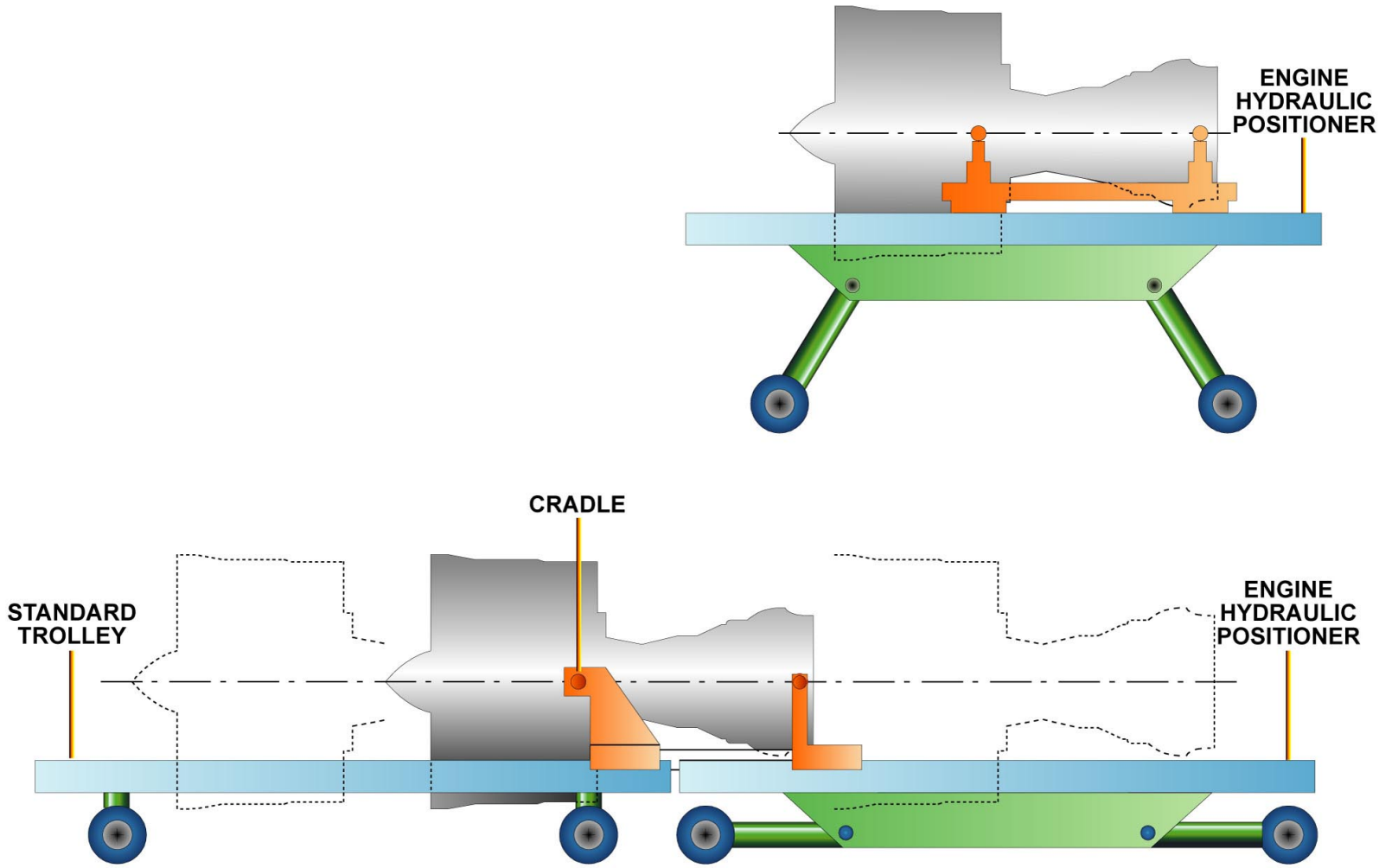

ENGINE HYDRAULIC POSITIONER

ENGINE REMOVAL AND INSTALLATION OVERVIEW (3)

ENGINE PRESERVATION

The preservation procedures protect the CFM56 engine against corrosion, liquid and debris entering the engine, and atmospheric conditions during periods of storage, and inactivity. This includes installed engines on inoperative aircraft or engines not to be operated for more than 30 days. The procedure recommended for preservation of the engine will vary depending upon the duration of inactivity, the type of preservation used, and if the engine is operable or non-operable.

NOTE: engines that can be started are considered operable. Engines that for any reason cannot be started are considered non-operable.

The preservation procedure to be used is based upon the following schedule: up to 30 days, up to 90 days, between 30 to 365 days, preservation renewal requirements, procedure for exceeded long term preservation and de-preservation. See Aircraft Maintenance Manual (AMM) for specific storage requests.

Before a preservation procedure some cautions must be observed.

CAUTION: if engine was ferried or subjected to an In-Flight Shutdown, engine must be dried out and re-lubricated within 24 hours as per dry out procedure of this section.

CAUTION: under no circumstances shall preservative oil or equivalent be sprayed into the engine inlet, core compressor or turbine, or engine exhaust. Dirt particles on wet blades and vanes may adversely affect engine performance during subsequent operation.

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PROTECTION AGAINST ATMOSPHERIC CONDITIONS

PRESERVATION PROCEDURE SCHEDULE

- UP TO 30 DAYS
- UP TO 90 DAYS
- BETWEEN 30 TO 365 DAYS
- PRESERVATION RENEWAL REQUIREMENTS
- EXCEED LONG TERM PRESERVATION
- DEPRESERVATION

CAUTION

IF ENGINE WAS FERRIED OR SUBJECTED TO AN IN-FLIGHT SHUTDOWN, ENGINE MUST BE DRIED OUT AND RE-LUBRICATED WITHIN 24 HOURS AS PER DRY OUT PROCEDURE OF THIS SECTION.

CAUTION

UNDER NO CIRCUMSTANCES SHALL PRESERVATIVE OIL OR EQUIVALENT BE SPRAYED INTO THE ENGINE INLET, CORE COMPRESSOR OR TURBINE, OR ENGINE EXHAUST. DIRT PARTICLES ON WET BLADES AND VANES MAY ADVERSELY AFFECT ENGINE PERFORMANCE DURING SUBSEQUENT OPERATION.

ENGINE PRESERVATION

ENGINE REMOVAL AND INSTALLATION OVERVIEW (3)

PRESERVATION RENEWAL REQUIREMENTS

You can refer to the AMM for preservation renewal requirements for operable and non operable engines.
To exceed long-term preservation, refer to your CFM International (CFMI) representative.

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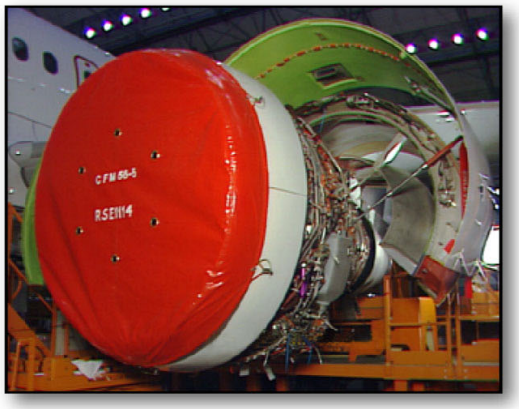
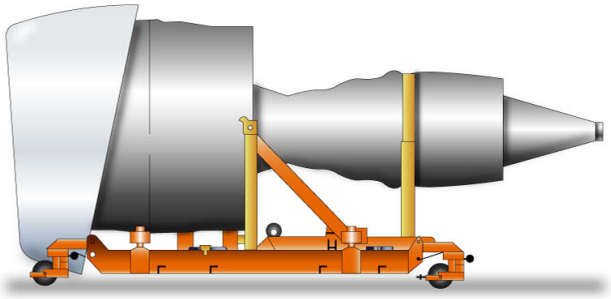


OPERABLE



NON OPERABLE

PERIOD	OPERABLE	NON OPERABLE
UP TO 30 DAYS	2 RENEWALS	NO RENEWAL
UP TO 90 DAYS	1 RENEWAL	X
30 TO 365 DAYS	NO RESTRICTION	NO RENEWAL

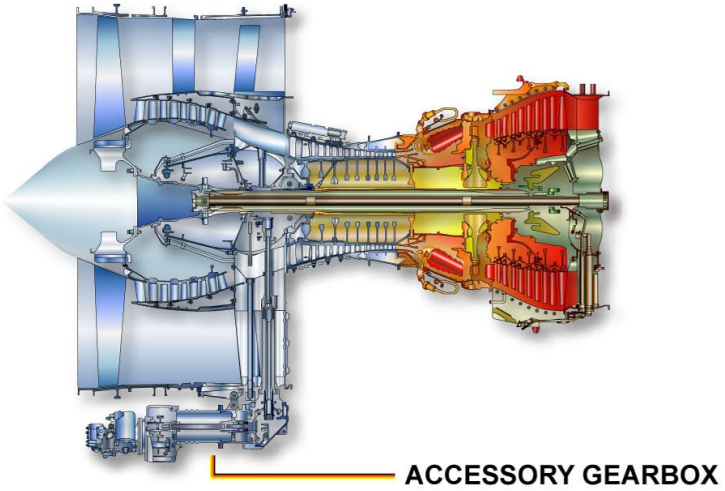
TO EXCEED LONG TERM PRESERVATION REFER TO YOUR CFMI REPRESENTATIVE

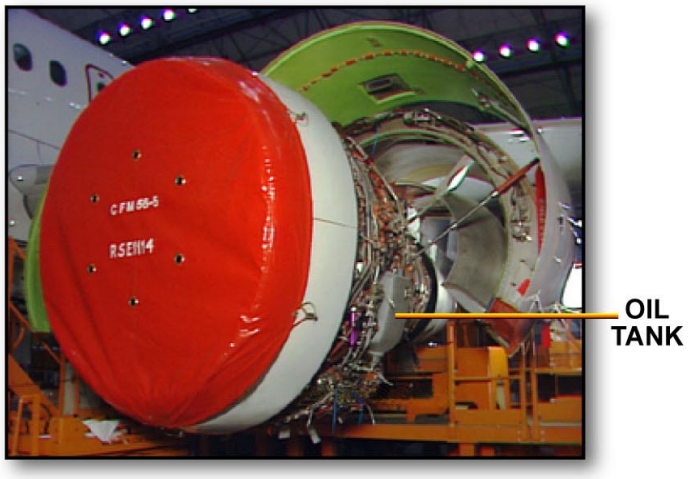
PRESERVATION RENEWAL REQUIREMENTS

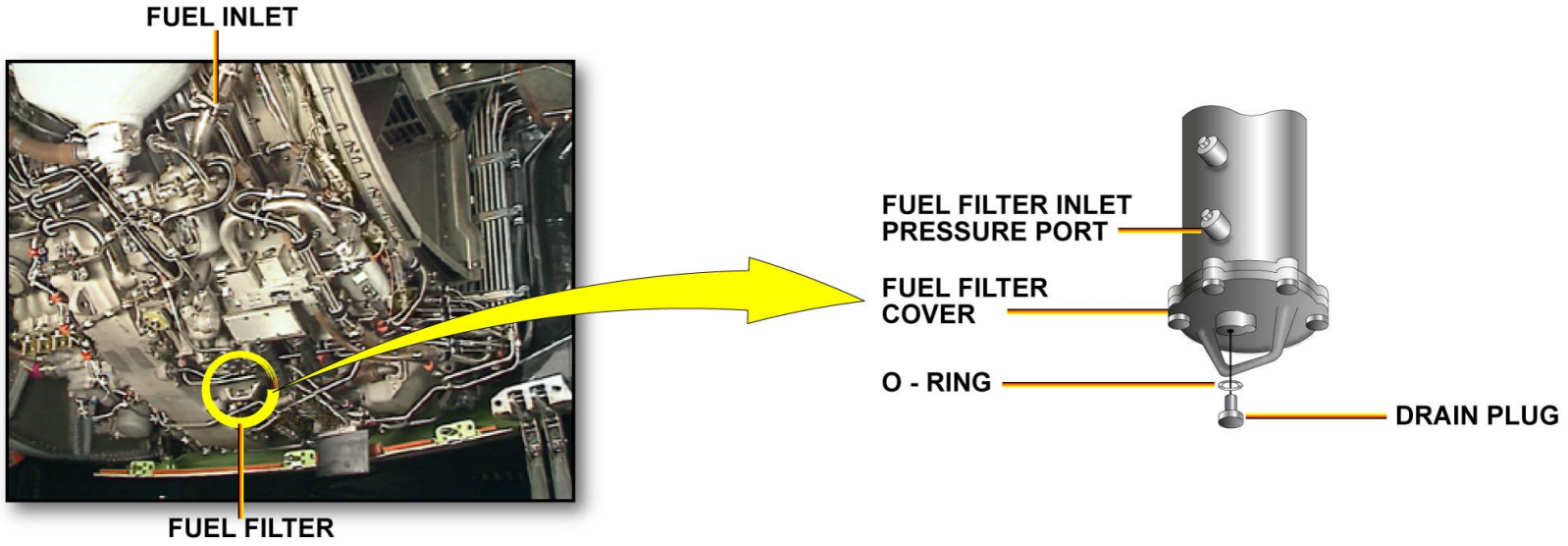
ENGINE REMOVAL AND INSTALLATION OVERVIEW (3)

ENGINE DEPRESERVATION

Remove all moisture barrier material, seals, caps, cover, etc., as applicable, from the engine.
Connect fuel supply, reconnect oil supply and scavenge lines if applicable and drain the oil tank.
Drain accessory drive assembly.
Fill the oil tank.
Do a wet motoring of the engine.
Do one or more dry motoring operations to remove the remaining fuel.







ENGINE DEPRESERVATION

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